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FINAL ALTERNATIVES ASSESSMENT
OTHER CONTAMINATION SOURCES IRA
SHELL SECTION 36 TRENCHES, RMA

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13. ABSTRACT *(Maximum 200 words)*

THIS DOCUMENT DESCRIBES THE PROCESS AND RESULTS OF THE ALTERNATIVES ASSESSMENT CONDUCTED FOR THE SHELL SECTION 36 TRENCHES (SITE 36-3), APPROXIMATELY 31 TRENCHES USED FROM 1952 TO 1966 FOR LAND DISPOSAL OF LIQUID AND SOLID WASTES GENERATED FROM PESTICIDE MANUFACTURE. THEY HAVE BEEN SHOWN TO BE A SOURCE OF GROUND WATER CONTAMINATION. A DENSE NON-AQUEOUS PHASE LIQUID (DNAPL) IS ALSO BELIEVED TO HAVE ORIGINATED FROM THE TRENCHES.

THE ASSESSMENT INCLUDES THE FOLLOWING:

1. SITE CHARACTERIZATION
2. DISCUSSION OF ALTERNATIVE STRATEGIES AND TECHNOLOGIES
3. EVALUATION OF ALTERNATIVES
4. CONCLUSIONS.

THE PREFERRED INTERIM RESPONSE ACTION CONSISTS OF 1) A PHYSICAL BARRIER ENCIRCLING THE TRENCHES AND 2) A SOIL AND VEGETATIVE COVER.

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1.0 INTRODUCTION

The Shell Section 36 Trenches (Shell Trenches) are listed with the "Remediation of Other Contamination Sources" Interim Response Action (IRA) sites in the Final Technical Program Plan FY88-FY92 and the Federal Facility Agreement. The process used to assess alternatives are specified in, and conducted in accordance with, the Federal Facility Agreement.

As specified in Section 22.6 of the Federal Facility Agreement, "The goal of the [alternatives] assessment is to evaluate alternatives and to select the most cost-effective alternative for attaining the objective of the IRA. The evaluation of alternatives may be based upon, but not limited to, such factors as protection of human health and the environment, mitigation of the threat to human health and the reasonableness of cost, and timeliness."

In accordance with the Federal Facility Agreement, alternatives that achieve the objective of the IRA are evaluated against guidelines listed in the Federal Facility Agreement and a preferred alternative selected. A hierarchical approach to the development and evaluation of alternatives has been taken to streamline the number of alternatives that must be evaluated. This approach consists of (1) evaluating general response-level alternatives (i.e., strategies) according to their ability to meet IRA objectives and attain IRA criteria (Section 4.1), (2) selecting a preferred strategy based on that evaluation (Section 4.1), (3) identifying appropriate technologies for the selected strategy (Section 4.2), (4) combining those technologies into system alternatives (Section 4.3), (5) evaluating those system alternatives according to the same IRA criteria (Section 4.3), and (6) selecting a preferred system alternative (Section 5.0).

2.0 SITE DESCRIPTION

This section provides a summary of the physical setting of the Shell Trenches. Detailed information on site characteristics and the field investigations conducted to determine those characteristics is provided in HLA (1986), Ebasco (1987, 1988), and Shell (1989a, 1989b).

2.1 LOCATION AND HISTORY

The Shell Trenches are located in the south-central portion of Section 36 of the RMA (Figure 2-1). Figure 2-2 shows the study area used for this IRA and the location of the trenches within the study area.

The Shell Trenches were used from 1952 to 1965 for land disposal of liquid and solid wastes generated from the manufacture of pesticides in the South Plants. Although no definitive records exist, the site of the trenches may also have been used for disposal by the Army prior to 1952 (Shell 1982).

Approximately thirty-one trenches, located in eighteen east-west trending rows, were excavated, partially filled with laboratory and plant wastes, and covered with excavated soils. The trenches were excavated from 5 to 10 feet below the surface of the ground. They are between 10 and 20 feet wide and are separated by 3 to 23 feet of undisturbed soil. Individual trenches range from approximately 40 to 660 feet in length (HLA 1986).

The exact composition and quantities of the assorted wastes disposed in the trenches are not known. Streich (1982) compiled a partial list of compounds and quantities thought to have been placed in the trenches based on historical process records (Table 2-1). Since disposal records were not routinely kept, the list

of compounds and quantities in Table 2-1 cannot be assumed to be completely accurate or comprehensive.

In addition to the compounds identified by Streich, other compounds that may have been contained in bulk or drummed process intermediates, off-specification product, or laboratory sample filters -- as well as rags, plastic and metal cans, glass jars, piping, pipe fittings, and insulation -- were disposed in the trenches (Shell unknown date and Streich 1982).

2.2 GEOLOGY

The trenches are located in moderately well-sorted, fine-grained, unconsolidated silty sand interpreted to be eolian in origin (Figure 2-3). The eolian sediments range in thickness from approximately 8 feet in the eastern part of the trenches to 17 feet in the west.

The eolian sand is underlain by a layer of silty clay interpreted to be eluvial in origin (Figure 2-3). This eluvial clay unit consists of 57 to 100 percent silt and clay, with the majority of tested sections consisting of 90 to 100 percent silt and clay. Narrow (i.e., 2- to 5-inch thick) lenses of fine-grained sand and silt occur within the clay section; they are discontinuous and form a small percentage of the clay unit.

The eluvial clay unit is continuous across the study area and ranges from 6 to 11 feet in thickness beneath the trenches. As discussed below, this silty clay layer forms a zone of low permeability that limits vertical migration of contaminants from the trench area. The surface of the clay layer, which slopes to the northwest, may also control the migration of dense non-aqueous phase liquids (DNAPLs) from the trenches.

The Denver Formation underlies the eluvial clay. It consists of grey to light brown, saprolitic siltstones and claystones interpreted to be fluvial in origin. The contact between the eluvial clays and the Denver Formation is variable; it ranges from a gradational contact, where little distinction can be made between the eluvial clays and Denver Formation, to a sharp contact defined by regolithic gravels of the Denver Formation.

2.3 HYDROLOGY

Two hydrogeologic units, corresponding to the eolian and eluvial units, occur in the trench area. Beneath and to the north and west of the trenches, the water table is in the eolian sand unit approximately 6 to 12 feet beneath ground surface. To the south and east, the location of groundwater is unknown; it may occur under semi-confined conditions within the low permeability eluvial clays or confined conditions within the underlying Denver Formation.

Groundwater in the eolian unit flows from the south to the north-northwest (Figure 2-4). The thickness of saturated eolian sand varies from 0 feet east and south of the trenches to 10 feet in the northwest portion of the study area (Figure 2-5). A small area of increased saturated thickness occurs immediately below the trenches. Seasonal fluctuations in water levels (and thus saturated thickness) vary by less than two feet.

Lateral hydraulic gradients within the eolian sands range from approximately 0.005 to 0.013 ft/ft. Hydraulic conductivity estimates derived from dissipation tests using cone penetrometer equipment range from 9×10^{-2} to 1×10^{-3} cm/sec. Based on the approximate composition of the intervals tested relative to that of the entire unit (as well as knowledge of hydraulic conductivity values for moderately well-sorted silty sands), the

hydraulic conductivity of the eolian unit as a whole is estimated to average between 1 x 10^{-3} cm/sec and 5 x 10^{-3} cm/sec.

Local recharge to the eolian sand is believed to occur within the trench area. Recharge is indicated by the lack of vegetation and presence of open cracks and subsidence pits in the area. The lack of vegetation contributes to a higher than normal surface runoff which tends to collect in the surface cracks and depressions over the trenches and immediately south of the trenches. Recharge in these collection areas is generally much greater than in adjacent areas. Based on estimates of flow and recharge, local recharge may account for a significant portion (i.e., up to 100 percent) of groundwater flow through the trenches.

The eluvial clay unit forms a layer of low permeability underlying the saturated eolian sands. In core samples, it appears moist but may not be saturated. Hydraulic conductivity estimates derived from dissipation tests in narrow sandy horizons within the eluvial clay range from 1 x 10^{-3} to 1 x 10^{-6} cm/sec. Based on the sediment type tested and the small percentage of that type in the unit as a whole (as well as knowledge of reasonable values for clayey materials), the vertical hydraulic conductivity of the eluvial clay unit is estimated to be approximately 1 x 10^{-6} cm/sec or less.

2.4 WATER QUALITY

The Shell Trenches have been shown to be a source of groundwater contamination for numerous volatile and semi-volatile RMA target analytes (Shell 1989a and Ebasco 1989). Table 2-2 summarizes groundwater quality data collected in April 1989 and shows which analytes appear to emanate from the Shell Trenches.

Organochlorine pesticide and organosulfur data are not included on Table 2-2 because they were not validated by PM-RMA.

2.5 DENSE NON-AQUEOUS PHASE LIQUID

A dense non-aqueous phase liquid (DNAPL) was found in one well approximately 100 feet north of the trenches (Well 36517). It has a specific gravity of 1.324 and a kinematic viscosity of 17.30 centistokes (i.e., one and one-third times denser and twenty times more viscous than water).

The DNAPL consists of 39 percent organochlorine pesticides, 6.8 percent volatile aromatic compounds, 1.4 percent volatile halogenated compounds, 0.76 percent semi-volatile halogenated compounds, and 0.65 percent DBCP (Table 2-3). Fifty-one percent of the DNAPL could not be identified by preliminary GC/MS scans. Some of this unidentified fraction may be emulsified water.

Based on the composition of DNAPL and its proximity to the site, the DNAPL is believed to have originated from the Shell Trenches. Because of its density, the DNAPL probably migrated vertically from the trenches, through the eolian sand to the top of the eluvial clay unit, where it ponded and flowed laterally along that surface. The eluvial clay unit has an intrinsic permeability approximately three orders of magnitude less than that of the eolian sand, and therefore, inhibits vertical flow of DNAPL. Flow of DNAPL along the top of the clay unit probably occurs along narrow, sinuous pathways and is controlled primarily by the topography of the surface of the clay unit, which slopes gently to the northwest.

TABLE 2-1
COMPOUNDS DISPOSED IN SHELL SECTION 36 TRENCHES.

Substance	Pounds
Aldrin	26,000
Allyl chloride	12,000
Anglamol Base A (used in Gear Oil Additive 399)	300
Atlox 1045 A (aldrin emulsifier)	300
Attapulgus clay	20,000
AZODRIN* insecticide	45,000
Barium chloride	1,100
Bentonite	100,000
Benzene	82,000
Bicycloheptadiene	600
BIDRIN* insecticide	6,100
BLADEX* herbicide	900
Bromine	4,500
Captax (used in Gear Oil Additive 403)	100
Carbon, activated	1,800
Carbon Tetrachloride	33,000
Chlorobenzene	110,000
Chloroform (exact location in Section 36 unknown)	36,200
4-Chloro-3,5-dinitrophenyl sulfone (SD 11829)	63,000
4-Chloro-3-nitrophenyl sulfone (SD 11832)	21,000
Chlorophenylmethyl sulfone	Trace?
CIODRIN* insecticide	1,400
Cyclohexane	26,000
DIBROM* (naled)	10,000
Dibromochloropropane	9,800
Dicyclopentadiene	49,000
Dieldrin	1,200
3,4-Dichloro-5-nitrophenyl methyl sulfone (SD 14011)	14,000
Dipropylamine hydrochloride	110,000
1,2,3,4,5,6,7,8,12,12a,13,13a,Dodecachloro-1,4:5,8:9,10 trimethanoanthracene (Diadduct)	650,000
Dowtherm A (mix of biphenyl + biphenyl oxide)	1,000
Endrin	840,000
Ferric chloride	25,000
Filter cartridges	390,000
Fullers earth	48,000
Glyceryl monooleate (used in Gear Oil Additive 403)	800
HCCPD impurities - mainly tetrachlorocyclopentane	210,000
1,2,3,4,5,7,7-Heptachloro-bicyclo-2,2,1, heptene-2 (773)	1,200
Heptane	52,000
1,2,3,4,10,10-Hexachloro-6-keto-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene (delta-keto)	470,000
Hexachlorocyclopentadiene (HCCPD)	69,000
Hexane	11,000
Hydrocarbons, heavy	89,000

TABLE 2-1 (continued)

Substance	Pounds
Isodrin	2,290,000
Isodrin impurities	3,700,000
Methanol	120,000
Methylacetoacetate (MAA)	4,300
Methylamine	900
N-N-Dimethyl 2-chloroacetoacetamide (DMCAA)	1,000
0-Methyl methylthiophosphonate	3,100
0-Methyl methylthiophosphonic acid	34,000
Methyl parathion (MEP)	13,000
Methyl polysulfide	34,000
Octachlorocyclopentene (OCCP)	260,000
O,O-Dimethyl chlorothionophosphonate (TAC)	62,000
O,O-Dimethyl methylthiophosphonate	2,700
Parathion (ethyl parathion)	600
Perchlorobenzene	330,000
Phenol	100
PHOSDRIN* insecticide	4,000
PLANAVIN* herbicide	28,000
PLANAVIN impurities	42,000
Primene 81R (used in Gear Oil Additive 403)	900
Retrol clay	1,300
Sodium bicarbonate	700
Sodium thiosulfate	300
Sulfur	11,000
Sulfuryl chloride	30,000
TAC impurities	14,000
2,2,2',4'-Tetrachloroacetophenone (TCAP) (SUPONA intermediate)	5,400
TCAP flasher bottoms	8,900
Tetramethylpyrophosphate and related	36,000
Tetramethylthionopyrophosphate	8,000
Toluene	130,000
Trem Y-24 (aldrin emulsifier)	2,200
Trex 40 (aldrin emulsifier)	1,900
Triethylamine (TEA)	100
3',4',5',-Trimethylphenol (TRIMP) (LANDRIN* insecticide intermediate)	12,000
VAPONA* insecticide	13,000
Versene Fe3 specific (endrin stabilizer)	440,000
Xylene	100

*Shell Trade Name

Source: Streich (1982).

TABLE 2-2
SUMMARY OF GROUNDWATER QUALITY DATA

Analyte	Frequency of Detection	Range of Upgradient Concentrations (ug/l)	Range of Downgradient Concentrations (ug/l)	Are the trenches a source of this compound?
PURGEABLE AROMATIC COMPOUNDS				
benzene	10/16	280-580	>10.5-39,000	probably
ethylbenzene	5/16	8.4	0.91-52.0	possibly
toluene	4/16	670	110-18,000	probably
o,p-Xylene	6/16	23.0	2.66-190	probably
m-Xylene	4/16	25.0	>90->100	probably
PURGEABLE HALOGENATED COMPOUNDS				
carbon tetrachloride	8/16	100-4300	15.8-230	no
chlorobenzene	3/16	19.2-51.0	no hits	no
chloroform	16/16	64.4-4300	27.3-17,000	probably
1,1-dichloroethane	1/16	no hits	130	possibly
1,2-dichloroethane	8/16	no hits	4.38-430	probably
1,1-dichloroethene	0/16	no hits	no hits	no
1,2-dichloroethene	1/16	no hits	120	probably
methylene chloride	12/16	15.3-1700	3.86-10,000	probably
1,1,1-trichloroethane	0/16	no hits	no hits	no
1,1,2-trichloroethane	4/16	34.0	31.0-160	unclear
tetrachloroethene	5/16	no hits	6.21-280	probably
trichloroethene	15/16	29.6-120	1.54-670	unclear
DIBROMOCHLOROPROPANE				
DBCP	16/16	13.0-900	4.2-2300	probably
VOLATILE HYDROCARBONS				
DCPD	6/16	no hits	510-3800	probably
MIBK	0/16	no hits	no hits	no
ORGANOPHOSPHORUS COMPOUNDS				
DIMP	9/16	46.5	100-590	probably
DMMP	4/16	no hits	110-660	probably
METALS				
arsenic	4/16	no hits	3.98-410	probably
mercury	0/16	no hits	no hits	no

TABLE 2-3
ANALYSIS OF DENSE NON-AQUEOUS PHASE LIQUID

Compound	ug/g (ppm)	Percent	Subtotal Percent
VOLATILE AROMATIC ORGANIC COMPOUNDS			
Toluene	62,000	6.2	
m-Xylene	2,800	0.28	
o-/p-Xylene	2,700	0.27	6.8
VOLATILE HALOGENATED ORGANIC COMPOUNDS			
Carbon Tetrachloride	8,800	0.88	
1,2-Dichloropropane	2,700	0.27	
Tetrachloroethene	2,300	0.23	1.4
ORGANOCHLORINE PESTICIDES			
Aldrin	110,000	11	
Dieldrin	31,000	3.1	
Endrin	62,000	6.2	
Endrin Aldehyde	7,700	0.77	
Endrin Ketone	4,900	0.49	
Isodrin	170,000	17	39
SEMIVOLATILE HALOGENATED ORGANIC COMPOUNDS			
Hexachloroethane	2,700	0.27	
Hexachlorobutadiene	2,400	0.24	
Hexachlorocyclopentadiene	1,800	0.18	
Pentachlorobenzene	140 (1)	0.01	
1,2,3,4-Tetrachlorobenzene	600	0.06	0.76
DIBROMOCHLOROPROPANE			
Dibromochloropropane	6,500	0.65	0.65
		TOTAL	49

Specific Gravity = 1.324 and kinematic viscosity = 17.30 centistokes.

(1) - Estimated concentration.

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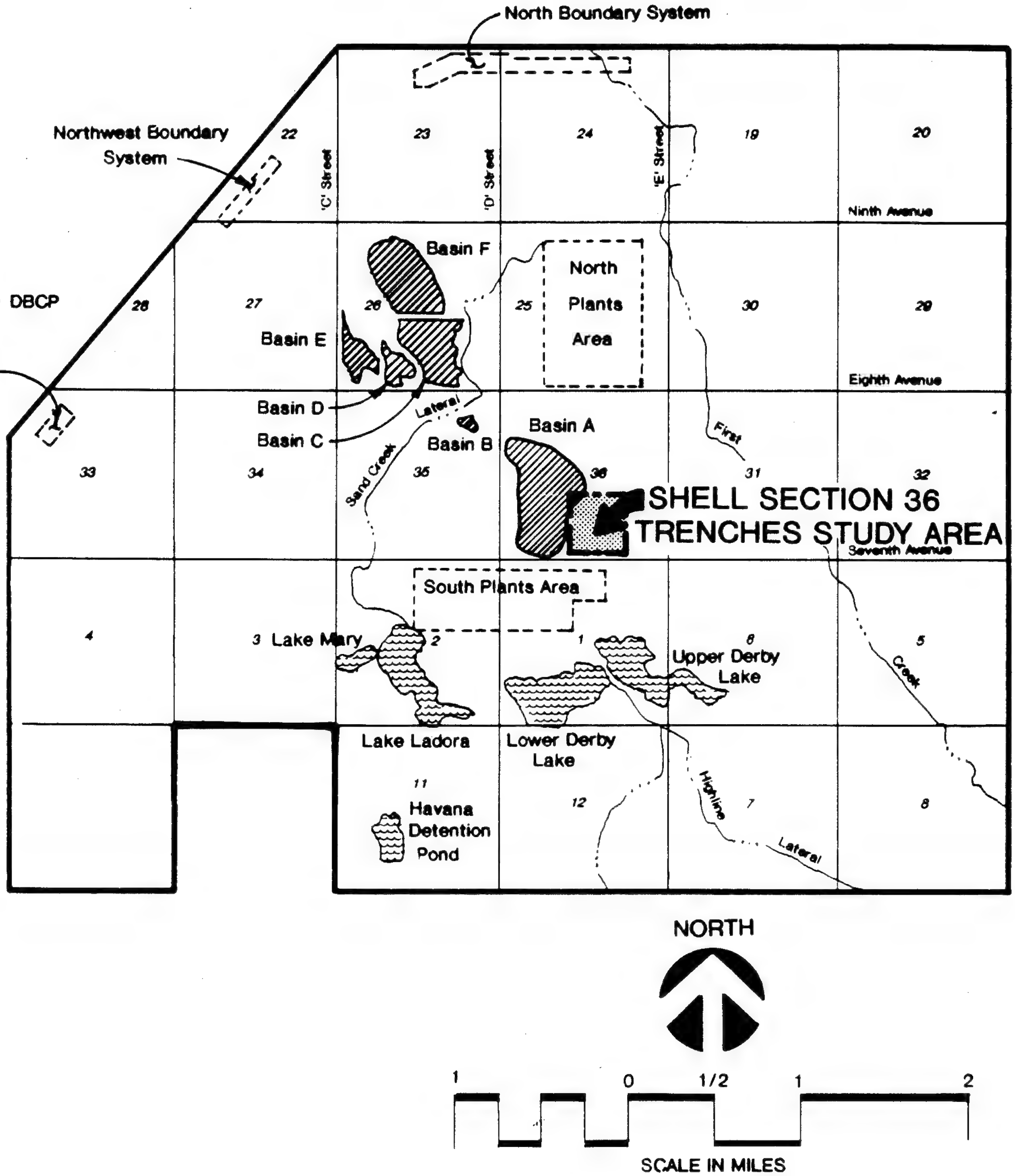

Figure: 2-1

Location Map of Shell Section 36 Trenches

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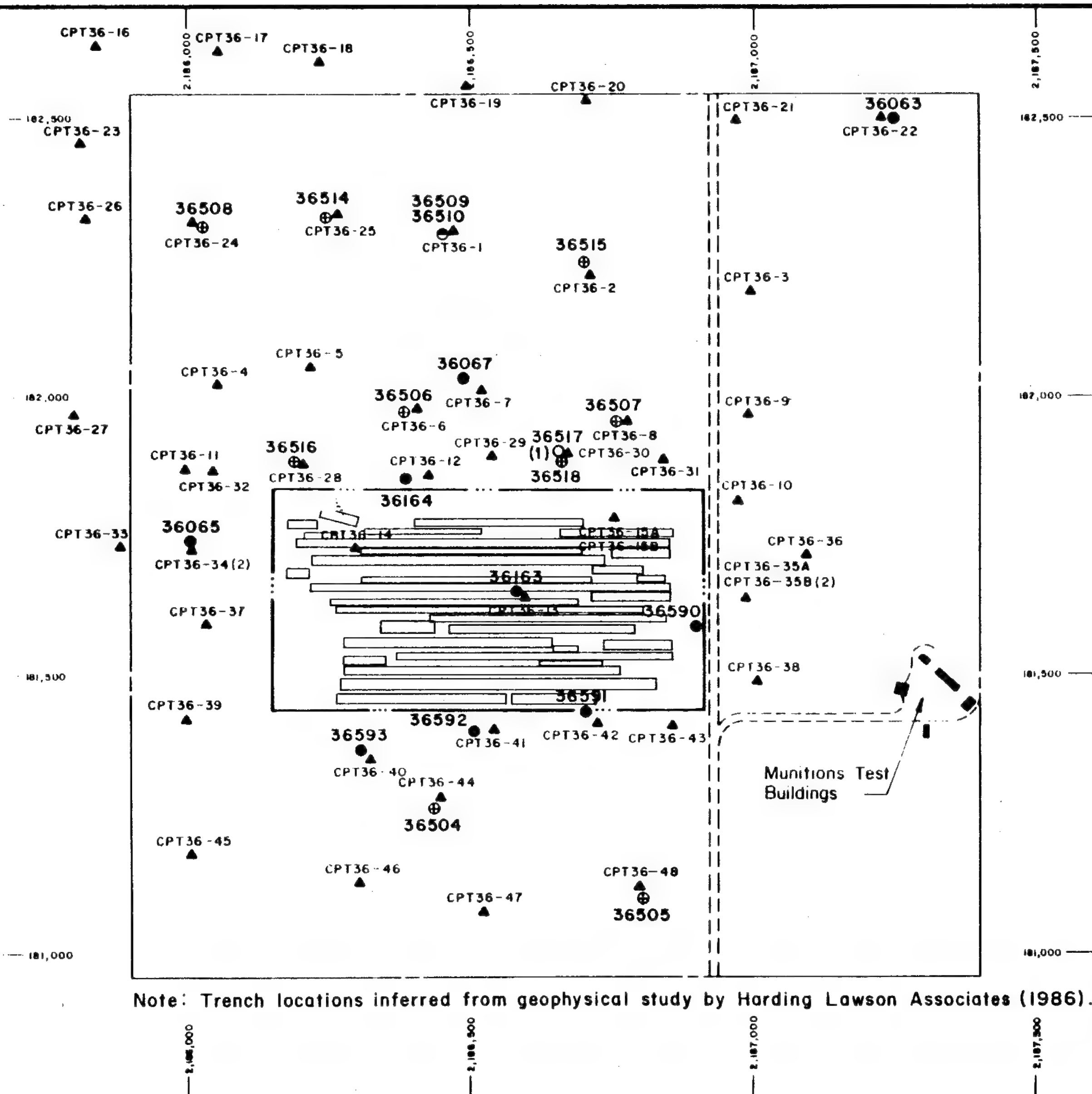
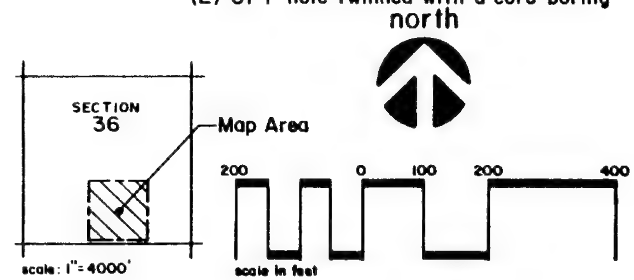


Note: Trench locations inferred from geophysical study by Harding Lawson Associates (1986).

Legend

- ● Previously Existing Alluvial Monitoring Well
- ⊕ Newly Installed Alluvial Monitoring Well
- ◓ Newly Installed Alluvial Cluster Well
- ▲ Newly Completed Cone Penetrometer Test Hole
- Approximate Maximum Extent of Trench Area
- ==== Dirt Road
- CPT 36-1 ▲ Cone Penetrometer Test Hole Identification
- 36508 ⊕ Well Identification
- 36517 ○ Abandoned Alluvial Monitoring Well

Notes: (1) Well 36517
a. Completed 9-21-89
b. Sampled for DNAPL 9-27-89
c. Abandoned 9-29-89
(2) CPT hole twinned with a core boring



Well and Cone Penetrometer Test Hole Location Map

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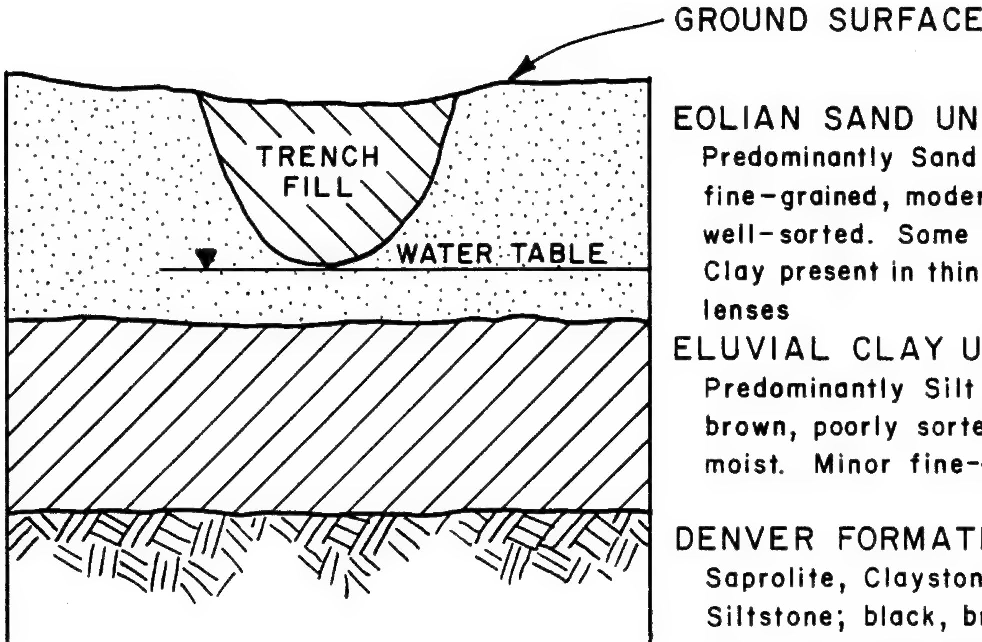
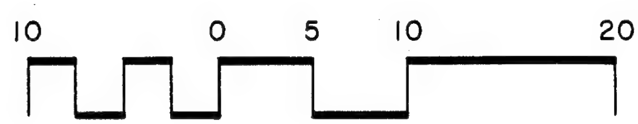
Figure: 2-2



EOLIAN SAND UNIT:
Predominantly Sand; brown fine-grained, moderately well-sorted. Some Silt and Clay present in thin beds or lenses

ELUVIAL CLAY UNIT
Predominantly Silt and Clay; brown, poorly sorted, mottled, moist. Minor fine-grained Sand.

DENVER FORMATION:
Saprolite, Claystone, Siltstone; black, brown, and gray, very weathered, moist to wet.



Scale in feet

Figure: 2-3

Schematic Cross Section in Trench Area

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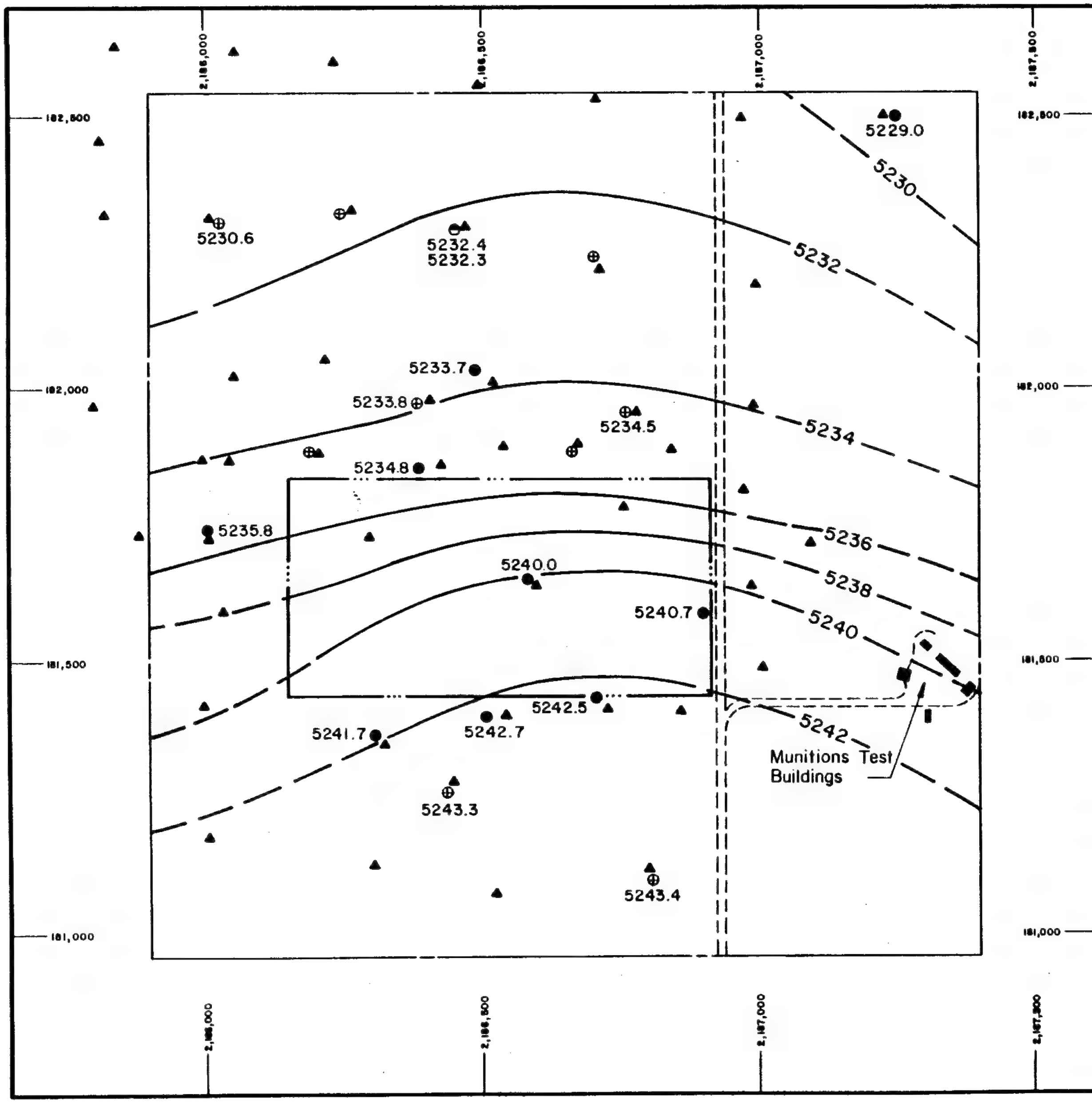
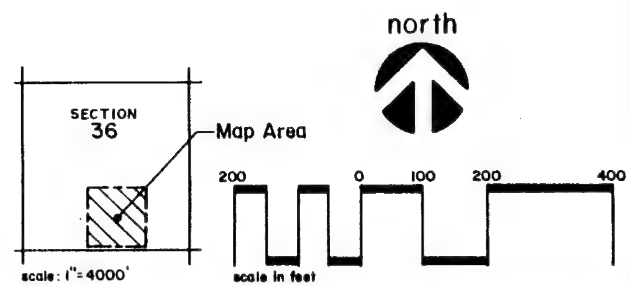


Legend

- ● Previously Existing Alluvial Monitoring Well
- ⊕ Newly Installed Alluvial Monitoring Well
- ◒ Newly Installed Alluvial Cluster Well
- ▲ Newly Completed Cone Penetrometer Test Hole
- Approximate Maximum Extent of Trench Area
- ==== Dirt Road
- ● 5233.7 Elevation of Water Level in Feet Above Mean Sea Level
- 5240 Contour Showing Water Level Surface Elevation in Feet Above Mean Sea Level; Dashed Where Inferred



Contour of Water Table

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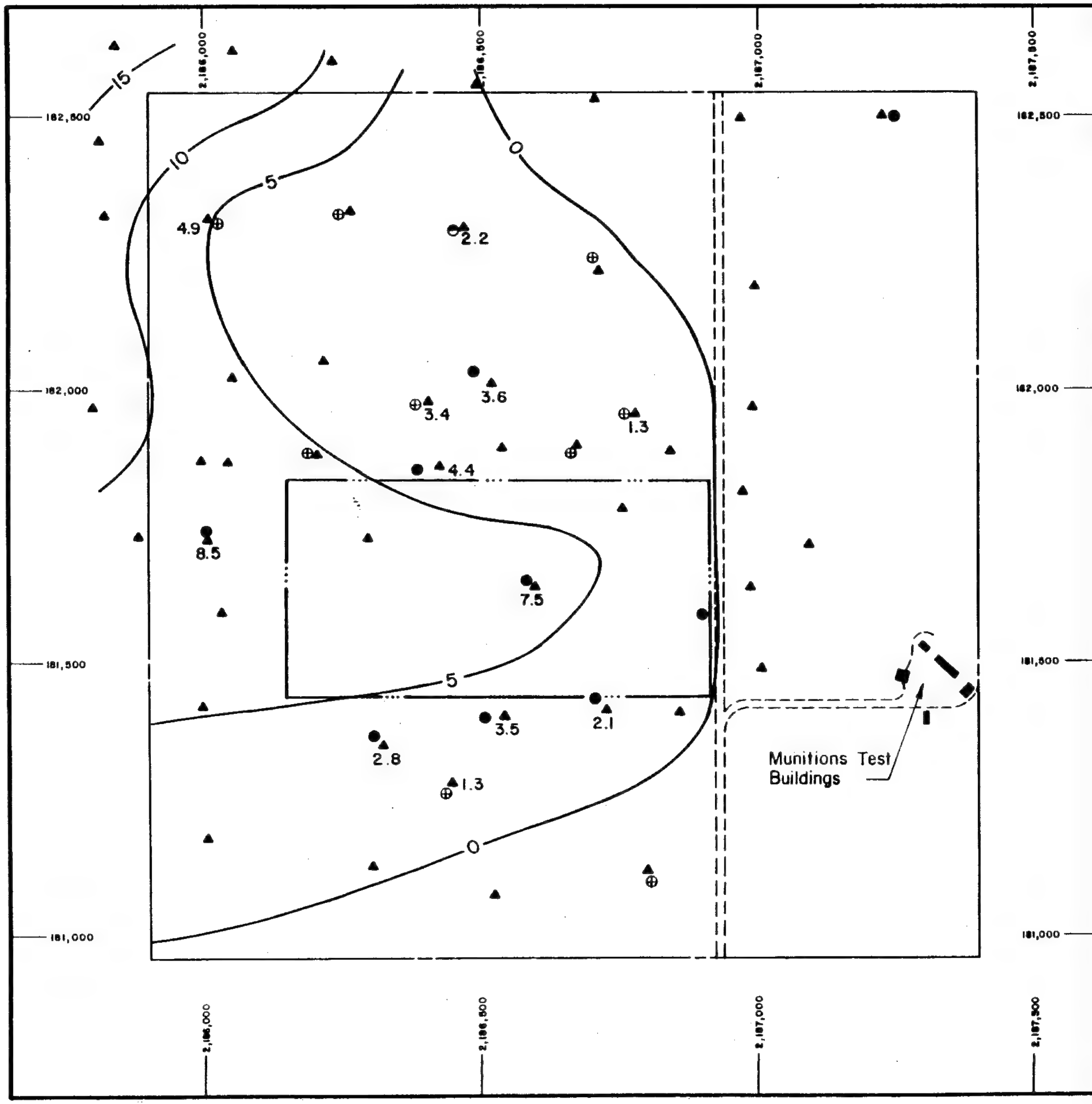
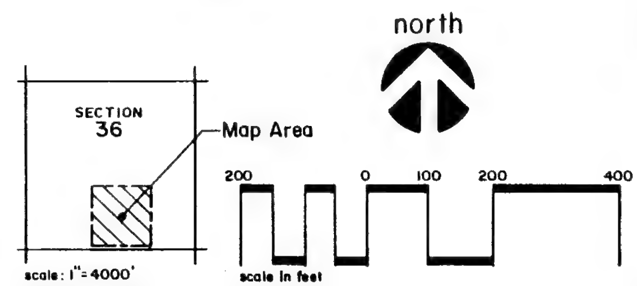
Figure: 2-4



Legend

- ● Previously Existing Alluvial Monitoring Well
- ⊕ Newly Installed Alluvial Monitoring Well
- ◓ Newly Installed Alluvial Cluster Well
- ▲ Newly Completed Cone Penetrometer Test Hole
- Approximate Maximum Extent of Trench Area
- ==== Dirt Road
- ▲ 2.2 Thickness of Saturated Eolian Unit in Feet; Water Level from Adjacent Well.
- 5 Approximate Isopach Showing Thickness of Saturated Eolian Unit in Feet

Note: Isopach of Saturated Eolian Unit determined from August 1989 water table and Eluvial Unit surface elevation.



Isopach of Saturated Eolian Unit

August 1989

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Figure: 2-5

3.0 INTERIM RESPONSE ACTION OBJECTIVE AND CRITERIA

The objective of this IRA is to reduce the lateral migration of contaminants emanating from the Shell Trenches. (The vertical migration of contaminants is inhibited by the eluvial clay unit described in Section 2.0). Since the issuance of the Draft Final Alternatives Assessment for the Shell Section 36 Trenches (Shell 1989a), DNAPLs were discovered in a monitoring well located approximately 100 feet north of the northernmost trench (Well 36517). The Interim Response Action alternatives discussed in this Alternatives Assessment address the reduction of both dissolved and separate-phase contaminant migration.

The criteria used to assess alternative strategies are listed in the Federal Facility Agreement. The Federal Facility Agreement was entered into by the Army, EPA, Shell, et al pursuant to CERCLA. Its purpose is to ensure compliance with all federal and state laws pertinent to the CERCLA cleanup of the RMA. As such, it provides guidance specific to the RMA and tasks described in the Final Technical Program Plan FY88-FY92. The criteria specified in the Federal Facility Agreement to assess alternative strategies that meet the objective of the IRA are:

(1) Protection of human health and the environment;

(2) Reasonableness of cost;

(3) Cost-effectiveness;

(4) Attainment of Applicable or Relevant and Appropriate Requirements (ARARs), to the maximum extent practicable;

(5) Timeliness; and

(6) Consistency with and contribution to the efficient performance of Final Response Actions, to the maximum extent practicable.

4.0 INTERIM RESPONSE ACTION ALTERNATIVES

4.1 ALTERNATIVE STRATEGIES

The strategies that are considered for this IRA are:

(1) No Action;
(2) Monitoring/Maintenance;
(3) Excavation;
(4) In-Situ Remediation; and
(5) Containment.

Each strategy is evaluated based upon its ability to meet the IRA criteria. However, if a strategy does not attain the objective of the IRA (which is to reduce the lateral migration of contaminants emanating from the Shell Trenches), it is eliminated without discussion of its ability to meet the IRA criteria.

4.1.1 No Action

Investigations have shown that contaminants are migrating laterally away from the Shell Trenches. The No Action alternative is eliminated as a strategy for this IRA because it does not meet the objective of the IRA, which is to reduce the lateral migration of contaminants emanating from the Shell Trenches.

4.1.2 Monitoring/Maintenance

A Monitoring/Maintenance alternative would consist of (1) monitoring groundwater and air at sufficient frequencies to ensure knowledge of any change in the extent of contamination until implementation of the Final Remedy, and (2) implementing institutional controls to prevent or reduce human and non-human

biotic access to the area of contamination. Similar to the No Action alternative, the Monitoring/Maintenance alternative is eliminated because it does not meet the objective of the IRA.

4.1.3 Excavation

An excavation strategy consists of removal of the contents of the trenches and contaminated soils, followed by temporary storage of the removed material and/or treatment and disposal of these materials. Although an excavation strategy would meet the IRA objective of reducing the lateral migration of contaminants emanating from the Shell Trenches, in comparison to the containment strategy it is not reasonable in terms of cost, cost-effectiveness, or timeliness.

Removal of the contents of the trenches requires (1) construction of a containment system to ensure protection of the environment during excavation; (2) excavation; (3) detailed waste characterization to screen and evaluate treatment technologies as well as assess the risk to the environment, workers, and the public of implementing those technologies; and (4) evaluation and implementation of treatment technologies or construction of an interim waste storage facility.

As discussed in Section 4.1.5, containment can be implemented in a timely and cost-effective manner as an IRA. Excavation, waste characterization, and evaluation and implementation of treatment technologies or construction of an interim waste storage facility would require significant periods of time (four to five years) and be very costly (potentially $100 million or more). The large time periods and costs estimated for this strategy result from the heterogeneity, complexity, and character of the materials in the trenches. These characteristics indicate that waste excavation and characterization will be a time consuming,

delicate, and costly activity. For these reasons, it is eliminated as a viable strategy for this IRA.

4.1.4 In-Situ Remediation

In-situ remediation comprises treatment technologies that are conducted in place (i.e., without extracting or excavating any materials). These technologies include vitrification and vacuum venting. Vacuum venting is eliminated as an applicable strategy because it is not applicable to the large concentrations or complex mix of contaminants present in the Shell Trenches.

In-situ vitrification is eliminated as an applicable strategy because it is not likely to be an effective or predictable technology for this type of site. Specifically, the Shell Trench site is much larger and more heterogeneous than sites in which in-situ vitrification has been conducted successfully. Moreover, the Shell Trenches probably contain large numbers of metal drums and material that would react unpredictably during vitrification releasing large quantities of heat. Therefore, in-situ remediation cannot be guaranteed to be effective nor implementable within a timely manner, if ever, and is eliminated as a viable strategy for this IRA.

4.1.5 Containment

A containment strategy consists of a system that inhibits the movement of groundwater and DNAPLs away from the Shell Trenches (e.g., physical barriers, recovery trenches, etc.). It meets the objective of the IRA.

A containment strategy is protective of human health and the environment by inhibiting contaminant migration. It is expected to cost approximately $3 million or less and therefore is more

reasonable in cost and cost-effective than excavation, the other strategy that meets the objective of the IRA (see Section 4.1.3).

A containment strategy can be implemented on a timely basis (i.e., two years or less) using proven technologies and can be expected to comply with ARARs to the maximum extent practionable. Lastly, it is reasonable to assume that a containment strategy is consistent with and contributes to the efficient performance of Final Response Actions by reducing the spread of contamination.

In summary, a containment strategy fulfills all the assessment criteria required for Interim Response Actions under the Federal Facility Agreement and is selected as the preferred strategy for the Shell Trenches IRA.

4.2 ALTERNATIVE TECHNOLOGIES FOR SELECTED STRATEGY

As described in Section 4.1, the selected strategy for the Shell Trenches IRA is containment of groundwater and DNAPL plumes emanating from the site. Technologies that may be used to achieve this strategy (i.e., surface capping; groundwater and DNAPL barriers, extraction, and treatment) are discussed below.

4.2.1 Surface Capping

Surface capping is an effective technology that reduces both migration of contaminants from the vadose zone to groundwater and total contaminant flow in groundwater at sites where local recharge represents a significant portion of total groundwater flow. In the Shell Trenches, surface capping would not significantly reduce the total amount of contaminants entering groundwater because of the probable presence of both DNAPLs and drums containing contaminants within the aquifer. However, it may significantly reduce total groundwater flow beneath the

trenches by eliminating local recharge. This reduction in total groundwater flow may be cost-effective when compared to extracting and treating groundwater flow attributable to recharge.

Simulations using the EPA Hydrologic Evaluation of Landfill Performance (HELP) model show that recharge on the RMA is effectively prevented by a soil and vegetative cover (i.e., regrading and revegetation). A soil and vegetative cover minimizes deep percolation by preventing surface ponding and maximizes transpiration by providing a uniform vegetative cover. Therefore, a soil and vegetative cover eliminates the need to extract and treat groundwater, and in combination with other technologies, meets the objective of reducing the migration of contaminants emanating from the Shell Trenches. For these reasons, it is retained as a viable technology.

4.2.2 <u>Groundwater and DNAPL Barriers</u>

Barriers are used to inhibit the flow of groundwater and DNAPLs. Two general types of barriers have relevance to this IRA: physical barriers and hydraulic barriers. In order to contain lateral migration of both groundwater and DNAPLs, at least one of these types of barriers is needed.

Hydraulic barriers are created by manipulating the water table so that no flowpaths extend through the desired barrier. They are not appropriate for the Shell Trenches because they cannot be guaranteed to prevent the migration of narrow, sinuous plumes of DNAPL. For this reason, a hydraulic barrier is not retained for further consideration.

Physical barriers can be made of a variety of materials (e.g., slurry walls, sheet piling, and chemical grout, etc.). Soil-

bentonite slurry walls are common barriers that have been used successfully on the RMA. Other types of slurry walls are sometimes utilized in conditions requiring the use of special materials, usually at a greater cost than that of a simple soil-bentonite wall. For the Shell Trenches, the soil-bentonite mixture is believed to be adequate for inhibiting the flow of groundwater and DNAPLs and is retained for further consideration. Compatibility tests of a soil-bentonite mixture with DNAPLs and contaminated groundwater may need to be conducted prior to implementation.

Sheet piling consists of interlocking metal plates that form a barrier to flow. Each individual plate is driven into place, eliminating the need to excavate potentially contaminated soils during installation. Grout can be injected along the joints in the sheet piling to reduce leakage. For the Shell Trenches, sheet piling with injected grout is believed to be adequate for inhibiting the flow of groundwater and DNAPLs and is retained for consideration. Compatibility tests between sheet piling and grout with DNAPLs may need to be conducted prior to implementation.

Chemical grouting consists of pressure injecting liquid chemical grout into evenly-spaced boreholes. Even though grout holes may be closely spaced in an attempt to achieve effective containment, verification of effective containment is difficult, and imperfections in grout curtains are probable. Because of these problems, chemical grouting is not retained for further consideration.

4.2.3 <u>Extraction of Groundwater and DNAPLs</u>

Extraction technologies may be necessary for containment alternatives that require recovery of groundwater or DNAPLs.

Technologies that are applicable to this site are recovery trenches and extraction wells.

Recovery trenches are conducive to groundwater and DNAPL extraction for sites with small saturated thicknesses or DNAPLs. In combination with a synthetic membrane (e.g., high-density polyethylene [HDPE]), they have been used successfully at other sites and can be effective because they allow: (1) containment and recovery of numerous, narrow, sinuous plumes of DNAPLs that cannot be recovered reliably with extraction wells; (2) containment and recovery of contaminated groundwater; and (3) differential extraction of groundwater and DNAPLs using density-sensitive level-sensing devices. For these reasons, recovery trenches with a synthetic membrane are retained for further consideration. Compatibility tests of HDPE with DNAPLs would need to be conducted prior to implementation.

Extraction wells may be utilized for containment alternatives that require extraction of groundwater. However, because of the tendency for DNAPLs to occur in narrow plumes and isolated pools, extraction wells are not reliable for extracting DNAPLs. Extraction wells are retained for further consideration in system alternatives that require extraction of groundwater, but not DNAPLs.

4.2.4 Treatment of Groundwater

Groundwater beneath the Shell Trenches contains a large suite and relatively high concentrations of volatile and semi-volatile compounds (Shell 1989a and Shell 1989b). Because of the emphasis on rapid IRA implementation, IRA guidelines generally encourage the use of proven technologies and discourage the use of treatment technologies requiring extensive treatability testing.

Based on the complex characteristics of contaminants and the IRA implementation guidelines mentioned above, treatment would probably require some combination of packed column air stripping, activated carbon adsorption, and UV/hydrogen peroxide oxidation processes. Each of these processes has proven capable in varying degrees (depending on specific compounds) of removing a wide range of organic contaminants.

The two onsite treatment options are (1) a new facility constructed for this IRA, and (2) modifications to the proposed new CERCLA Wastewater Treatment System. A new treatment facility would require influent storage, treatment equipment, effluent storage, a treatment building, an access roadway, and all associated interconnecting piping and electrical/instrumentation hardware. According to the Revised Draft Assessment for the CERCLA Wastewater Treatment System (WES 1989), all the major components for treatment listed above are already included in the design for the CERCLA facility.

Modifications and capital expenditures that would probably be required for the CERCLA facility are (1) a transfer pipeline to convey approximately 2 gpm groundwater to the facility; (2) additional tankage for storage of raw and treated groundwater; and (3) an increase in treatment capacity from the proposed 10 gpm to approximately 11-12 gpm. These modifications are much more cost-effective in terms of capital expenditure than constructing a new facility. Moreover, modifications to the CERCLA facility provide greater long-term flexibility of treatment options for other IRAs and projects conducted under the Final Response Actions. For these reasons, onsite treatment in the modified CERCLA facility is the selected strategy for groundwater treatment if the selected IRA system requires such treatment.

4.2.5 Treatment and/or Storage of DNAPLs

Three methods are considered for treatment and/or storage of DNAPLs extracted from the Shell Trenches. They are: offsite treatment and disposal, onsite temporary storage, and onsite treatment with residues placed either in temporary storage or shipped offsite for disposal. If recovery trenches are utilized in this IRA, one of these methods will be necessary.

Onsite treatment could be conducted either in a process plant dedicated to this IRA or possibly one shared with another RMA site. Onsite treatment would require extensive pilot testing, sizing, and compliance with substantive regulatory requirements. These tasks and the resulting treatment facility could be cost-effective only if an accurate estimate of the total volume and composition of DNAPLs expected could be made. Because of the complex nature of DNAPL plumes and residuum in the subsurface, a reasonable estimate could only be made after an extensive and detailed field investigation. Therefore, onsite treatment in a new process plant designed for this IRA is eliminated as an applicable technology because it cannot be implemented in a timely manner.

Onsite treatment could probably be achieved in a facility shared with another RMA site. However, no other facility has at this time been identified. Therefore, onsite treatment in a facility shared with another RMA site will not be considered for this IRA.

Onsite storage could be accomplished by storing DNAPLs in an interim storage facility. Extracted DNAPLs could be stored either in 55-gallon drums, existing tanks, or tanks constructed for this IRA. Since the volume of DNAPLs extracted cannot be estimated with certainty, 55-gallon drums or existing storage tanks may be more desirable because they allow flexibility in

storage volume. The approximate cost of onsite temporary storage is $5.70 per gallon assuming a total volume of 5000 gallons of DNAPL, storage in 55-gallon drums for a period of 5 years, and use of an existing storage facility. Because this technology can be implemented in a timely and cost-effective manner, onsite temporary storage of recovered DNAPLs is retained for further consideration.

DNAPLs could be shipped offsite for treatment and disposal in an authorized facility. However, the estimated unit costs for offsite treatment and disposal are greater than for onsite temporary storage. Offsite treatment and disposal is estimated to cost approximately $7.50 per gallon. In comparison to onsite temporary storage, offsite treatment and disposal is not cost-effective and is not retained for further consideration.

4.3 ALTERNATIVE SYSTEMS FOR SELECTED STRATEGY

Three alternative systems that achieve the strategy of containment are described and evaluated in this section. Each of the alternatives comprises combinations of technologies described in Section 4.2. All of the alternatives are believed to be equally protective of human health and the environment, capable of achieving ARARs to the maximum extent practicable, timely, and consistent with the Final Response Actions. Consequently, they are evaluated primarily on cost-effectiveness in this section. Functional advantages and disadvantages for each alternative are also described.

The cost estimates for the three system alternatives were developed for comparison purposes only. The operating life of this IRA is assumed to be 5 years.

Conservative calculations indicate that the average eolian groundwater flow through the trenches could be as high as approximately 2 gallons per minute (gpm). This flowrate corresponds to 5.3 million gallons of groundwater over the assumed 5 years of this IRA.

4.3.1 Constructing and Operating a Recovery Trench Downdip and Downgradient and Extracting Groundwater and DNAPLs

The first alternative consists of constructing a recovery trench (keyed into the eluvial clay) downdip and downgradient of the Shell Trenches. Groundwater and DNAPLs would be collected in and extracted from the recovery trench. Extracted groundwater would be treated in the CERCLA wastewater facility; DNAPLs would be placed in an onsite temporary storage facility.

The potential advantage of this alternative is that it actively removes contaminants from the site. However, the total amount of contaminants that would be extracted from the site during the IRA is probably insignificant relative to the amount of contaminants present in the trenches and in associated Basin A and South Plants groundwater systems. The total amount of DNAPL that would collect in the trench over the period of the IRA is expected to be small because of the high viscosity (i.e., twenty times that of water) and consequently low flowrate of DNAPL. Therefore, if contaminants can be effectively contained using another alternative, the potential advantage of collecting and removing a small portion of contaminants does not justify additional expense.

Table 4-1 presents a cost estimate for this recovery alternative. It shows that the costs are approximately equivalent to the second alternative described (Section 4.3.2 and Table 4-2), but nearly twice as expensive as the third (passive containment)

alternative described in Section 4.3.3 (Table 4-3). Additionally, the costs for this first alternative contain a greater degree of uncertainty associated with uncertainty in estimates of flowrates and consequential increases in complexity of operation than the third (passive) containment alternative.

In summary, the potential advantage of this recovery alternative is outweighed by the disadvantage of significantly higher costs and complexity of operation without commensurately greater benefits. For these reasons, this alternative is not cost-effective and is eliminated as a viable alternative for this IRA.

4.3.2 Encircling the Shell Trenches with a Physical Barrier and Extracting Groundwater

The second alternative consists of encircling the trenches with a physical barrier and regulating water levels within the enclosure by extracting groundwater. The physical barrier would be keyed into the eluvial clay. Extracted groundwater would be treated in the CERCLA wastewater facility; DNAPLs would not be extracted.

One potential advantage of this alternative is that a reverse gradient could be achieved across the physical barrier. However, because the flowrates are low, saturated eolian aquifer is thin, and the life of the IRA is only 5 years, a reverse gradient is probably not necessary to effectively contain contaminants. Moreover, the costs associated with treating the groundwater extracted to maintain the reverse gradient are not justified by the small increase in confidence of containment that would be achieved (Tables 4-2 and 4-3).

One disadvantage of this alternative is that DNAPLs within the saturated eolian unit may be drawn downward through the eolian sand under the steep hydraulic gradients induced by groundwater

extraction. This effect may result in contaminating soils that are currently uncontaminated and should be avoided because the goal of an IRA is the reduction of migration of contaminants.

Table 4-2 presents a cost estimate for this second alternative. It shows that the estimated costs are approximately equivalent to the costs estimated for the first alternative, but are nearly double those of the third (passive containment) alternative. Moreover, the costs for this second alternative have a greater degree of uncertainty than the third alternative resulting from uncertainty of flowrates that would be extracted.

In summary, the potential advantage of this recovery alternative is outweighed by the potential disadvantage of inducing vertical movement of DNAPLs and the disadvantage of significantly higher costs and complexity of operation without commensurately greater benefits. For these reasons, this second alternative is not cost-effective and is eliminated as a viable alternative for this IRA.

4.3.3 Encircling the Shell Trenches with a Physical Barrier and Constructing a Soil and Vegetative Cover

The third alternative is a conceptually simple containment system that is also protective of human health and the environment. It consists of encircling the Shell Trenches with a physical barrier and constructing a soil and vegetative cover to inhibit recharge. The physical barrier would be keyed into the eluvial clay. The soil and vegetative cover would effectively eliminate recharge and, therefore, the need to extract groundwater within the enclosure.

This system alternative assumes that for the period of this IRA, a reverse-gradient will not need to be maintained across the

containment wall. Containment of contaminants is expected to be effective for the 5-year life of the IRA without maintaining a reverse gradient because of the small saturated thickness of the eolian aquifer.

The primary functional advantages of encircling the trenches and eliminating recharge are the minimal operation and maintenance required. Both groundwater and DNAPLs within the enclosure would be contained, but neither would need to be extracted or treated as a part of the IRA. These functional advantages result in lower costs than the other alternatives while still meeting the objective and other criteria of the IRA.

Table 4-3 provides a cost estimate for this alternative. A soil-bentonite slurry wall is used as a representative physical barrier for this estimate. The estimate assumes that excavated soils will be mixed with the bentonite slurry and any excess soils will be placed within the enclosed area under the soil and vegetative cover. (An evaluation between the types of physical barriers will be conducted during preliminary engineering.)

The effect of this alternative on local hydrology is that groundwater within the enclosure would seek an elevation of approximately 5238 ft (i.e., the currently northward-sloping water table would tend to become level, resulting in higher water levels in the northern end of the enclosure and lower water levels in the south). Groundwater levels outside the barrier would decrease because of the elimination of recharge from the trenches (see Section 2.3).

Of the three alternatives discussed in this section, this passive containment alternative is the least expensive and most cost-effective. The cost estimate has the smallest amount of uncertainty because it does not rely on estimates of groundwater

or DNAPL flow. Moreover, this alternative minimizes the risk of unforeseen events by providing an operationally simple system.

This passive containment alternative is protective of human health and the environment, is reasonable in cost, cost-effective, can be expected to achieve ARARs to the maximum extent practicable, can be implemented in a timely manner, and is expected to be consistent with and contribute to the efficient performance of the Final Response Action. For these reasons, this alternative is selected as the preferred alternative for the Shell Trenches IRA.

TABLE 4-1
ESTIMATED COSTS OF CONSTRUCTING AND OPERATING A RECOVERY TRENCH DOWNDIP AND DOWNGRADIENT OF THE TRENCHES AND EXTRACTING GROUNDWATER AND DNAPLS

ASSUMPTIONS:

1) Extracted groundwater is treated in CERCLA wastewater facility. Design flowrate is 2 gpm.
2) Extracted DNAPLs are stored onsite for duration of IRA.
3) Excavated soils will be placed on top of trench area.
4) Cost of Capital for determining present value of annual costs is 5 percent per annum. Annual costs are assumed to occur at the beginning of the year.

CAPITAL COSTS:

	Unit	Unit Cost	Quantity	Cost
1) Recovery Trench System	LF	$ 77	1600	$ 123,000
2) Dewatering Station	LS	$ 77,000	1	$ 77,000
3) Geophysical Screening	LS	$ 17,000	1	$ 17,000
4) Monitoring Wells	EA	$ 2,000	20	$ 40,000
5) Modification of CERCLA Treatment Facility	LS	$ 360,000	1	$ 360,000
			Subtotal	$ 617,000
5) Engineering Design (20%)				$ 123,000
6) Supervision/General Expense Overhead/Health & Safety (30%)				$ 185,000
7) General Administration (10%)				$ 62,000
8) Contingency and Fee (25%)				$ 154,000
			Total Capital Cost	$1,141,000

ANNUAL OPERATION AND MAINTENANCE COSTS:

	Unit	Unit Cost	Quantity	Cost
1) Groundwater Treatment	GAL	$ 0.23	1,051,000	$ 242,000
2) DNAPL storage	GAL	$ 5.70	1000	$ 6,000
3) Quarterly Measurement of DNAPLs	WELL	$ 120	80	$ 10,000
4) Semi-Annual Groundwater Monitoring	WELL	$ 3000	40	$ 120,000
			Total Annual O&M Cost	$ 378,000

Present value of Capital Costs and 5 years of O&M costs is estimated to be $2,900,000.

TABLE 4-2
ESTIMATED COSTS OF ENCIRCLING SHELL TRENCHES
WITH A PHYSICAL BARRIER AND EXTRACTING GROUNDWATER

ASSUMPTIONS:

1) Soil-bentonite slurry wall is used for physical barrier.
2) Groundwater levels within the physical barrier are regulated by operating an extraction well within the containment enclosure.
3) Extracted groundwater is treated in CERCLA treatment facility. Design flowrate is 2 gpm.
4) DNAPLs are not extracted.
5) Excavated soils will be mixed with bentonite slurry. Remaining excavated soils will be placed on top of trench area.
6) Cost of capital for determining present value of annual costs is 5 percent per annum. Annual costs are assumed to occur at the beginning of the year.

CAPITAL COSTS:

	Unit	Unit Costs	Quantity	Cost
1) Slurry Wall	SF	$ 7.00	29,500	$ 207,000
2) Geophysical Screening	LS	$ 25,000	1	$ 25,000
3) Monitoring Wells	EA	$ 2,000	20	$ 40,000
4) Extraction Well	LS	$ 17,000	1	$ 17,000
5) Modification of CERCLA Treatment Facility	LS	$ 360,000	1	$ 360,000
			Subtotal	$ 649,000
4) Engineering Design (20%)				$ 130,000
5) Supervision/General Expense Overhead/Health & Safety (30%)				$ 195,000
6) General Administration (10%)				$ 65,000
7) Contingency and Fee (25%)				$ 163,000
		Total Capital Cost		$1,202,000

ANNUAL OPERATIONS AND MAINTENANCE COSTS:

	Unit	Unit Costs	Quantity	Cost
1) Groundwater Treatment	GAL	$ 0.23	1,051,000	$242,000
2) Quarterly Measurement of DNAPLs	WELL	$ 120	$ 80	$ 10,000
3) Semi-Annual Groundwater Monitoring	WELL	$ 3000	$ 40	$120,000
		Total Annual O&M Cost		$372,000

Present value of Capital Costs and 5 years of O&M costs is estimated to be $2,900,000.

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TABLE 4-3
ESTIMATED COSTS OF ENCIRCLING SHELL TRENCHES
WITH A PHYSICAL BARRIER AND
CONSTRUCTING A SOIL AND VEGETATIVE COVER

ASSUMPTIONS:

1) Soil-bentonite slurry wall is used for physical barrier.
2) Reverse gradient will not be required.
3) Soil and Vegetative Cover is used to limit recharge.
4) Excavated soils will be mixed with bentonite slurry. Remaining soils will be placed beneath the soil and vegetative cover.
5) Cost of capital for determining present value of annual costs is 5 percent per annum. Annual costs are assumed to occur at the beginning of the year.

CAPITAL COSTS:

	Unit	Unit Costs	Quantity	Cost
1) Slurry Wall	SF	$ 7.00	29,500	$207,000
2) Geophysical Screening	LS	$ 25,000	1	$ 25,000
3) Monitoring Wells	EA	$ 2,000	20	$ 40,000
4) Clay and Topsoil Cover	BCY	$ 6.00	37,500	$225,000
5) Vegetative Cover	ACRE	$ 1,200	10	$ 12,000
			Subtotal	$509,000
4) Engineering Design (20%)				$102,000
5) Supervision/General Expense Overhead/Health & Safety (30%)				$153,000
6) General Administration (10%)				$ 51,000
7) Contingency and Fee (25%)				$127,000
		Total Capital Cost		$942,000

ANNUAL OPERATIONS AND MAINTENANCE COSTS:

1) Quarterly Measurement of DNAPLs ($120 per Well; 20 wells)	$ 10,000
2) Semi-Annual Groundwater Monitoring ($3000 per well; 20 wells)	$120,000
Total Annual O&M Cost	$130,000

Present value of Capital Costs and 5 years of O&M costs is estimated to be $1,500,000.

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5.0 CONCLUSIONS

The selected strategy for the Shell Trenches IRA is containment. Each of the three system alternatives described in Section 4.3 are viable options that meet the objective of the IRA, are protective of human health and the environment, can attain ARARs to the maximum extent practicable, and can be implemented on a timely basis. On a cost basis, the physical barrier encircling the trenches with a soil and vegetative cover (i.e., passive containment) is the most reasonable and cost-effective.

For these reasons, the preferred Interim Response Action consists of a physical barrier encircling the trenches and a soil and vegetative cover. The physical barrier will be keyed into the eluvial clay. The exact location and northernmost extent of the physical barrier will be based on all available data during engineering design. The soil and vegetative cover (i.e., regrading and revegetation) will be constructed to prevent recharge and the consequential rise of water levels within the enclosure.

In addition to a passive containment system, a field investigation of DNAPLs that may exist downgradient and downdip of the known location of DNAPLs (i.e., Well 36517) will be conducted. Based on the results of the investigation, an interim response action (if necessary) will be conducted either as a modification of this IRA according to Section 22.16 of the Federal Facility Agreement or as a separate, new IRA according to Section 22.1(l) of the Federal Facility Agreement.

The major assumptions upon which the selection of this passive containment system alternative is based will be verified during the preparation of the Implementation Document for this IRA. If differences between the assumed and actual conditions are

significant, the selection of this alternative may be re-evaluated.

6.0 REFERENCES

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APPENDIX A

COMMENTS AND RESPONSES

SHELL RESPONSES TO ARMY COMMENTS ON THE
DRAFT FINAL ALTERNATIVES ASSESSMENT
OTHER CONTAMINATION SOURCES IRA, SHELL SECTION 36 TRENCHES, RMA

RESPONSES TO GENERAL COMMENTS

1. COMMENT:

The Army is concerned that this document does not actually assess any specific alternatives for mitigating the release of contaminants from the Shell Section 36 Trenches. Four general strategies (no action, monitoring, containment, removal) are discussed and a conclusion is reached that containment is the appropriate strategy for this IRA. However, there is no indication of which one of numerous containment alternatives may be used or even which technologies or groups of technologies are preferred. In the final assessment, alternatives should be developed and discussed, and a preferred alternative identified.

RESPONSE:

Shell agrees with the Army's comment and has developed, evaluated, and selected specific alternatives in the Final Alternatives Assessment.

2. COMMENT:

Shell has chosen to emphasize cost as a consideration in this document and a number of technologies are either rejected or considered further based on their "cost-effectiveness" or lack thereof. However, no data is presented to support any of these statements. A cost

comparison of the alternatives presented in the final assessment should be developed so that objective decisions relative to cost can be made.

RESPONSE:

Cost estimates are included in the Final Alternatives Assessment for each system alternative.

3. COMMENT:

Several statements are made about evaluations or comparisons to criteria when in fact none are presented in the document. The conclusions are presented, but the Army has not been provided with the evaluation process. This casts the validity of these conclusions in doubt. This situation is partially the result of Shell using the terms "technology, alternative, strategy, and system alternative" almost interchangeably. Refer to the introductions to Sections 5.0, 6.0, and 7.0 for examples.

RESPONSE:

The Final Alternatives Assessment has been reorganized and terms defined. Specific criteria listed in the Federal Facility Agreement have been included in the document and are used as a basis for the evaluations of strategy and system-level alternatives.

RESPONSES TO SPECIFIC COMMENTS

1. COMMENT:

Section 3.0, page 3-3. The Army contends that this is not a criteria section. Shell has merely paraphrased certain sections of the FFA and TPP to emphasize desired points. Paragraph 22.6, for example, could be paraphrased to state "The evaluation of alternatives may be based upon . . . protection of human health and the environment, mitigation of the threat to human health . . . and timeliness" and a very different emphasis is achieved. Clearly stated guidelines and criteria by which to evaluate alternatives should be presented in the final assessment.

RESPONSE:

Shell has specifically listed the criteria upon which the evaluation of alternatives is based in the Final Alternatives Assessment.

2. COMMENT:

Section 4.4, page 4-8. If the water table is 6 to 12 feet below surface and the trenches are approximately 10 feet deep, then the water table could be 2 feet below to 4 feet above the bottom of the trenches, not "within 2 feet of the bottom" as stated. This discussion should be clarified.

RESPONSE:

The text has been modified.

3. COMMENT:

Section 4.5, page 4-9, top of page. The Army notes the absence of OCP and OSC data and the statement "The exclusion of the . . . data, although critical for design, does not alter the evaluation of alternatives and conclusions set forth in this document." The Army agrees with this approach and finds it wholely consistent with its approach on the other "hot spots."

RESPONSE:

No response required.

4. COMMENT:

Section 4.5, pages 4-9 and 4-10. Shell stresses that the new wells yield the most accurate data but data seem to be treated equally in the discussion on page 4-9 (bottom) and page 4-10. This should be clarified in the final assessment.

RESPONSE:

The data used in the Draft Alternatives Assessment are primarily data from the new wells. Data from old wells with different screen intervals are used only in the absence of other data. We appreciate the comment made by the Army, although we have not included a revised version of that portion of the text in the Final Alternatives Assessment because we believe that new stratigraphic and chemical data are more important to the evaluation and selection of alternatives. The initial data were obtained solely to

determine whether the trenches are a source of contamination. This determination being completed, the physical setting portion of the text has been updated to include our new stratigraphic and chemical data necessary for the evaluation and selection of an alternative.

5. COMMENT:

Section 5.0, page 5-12. The statement is made that "Finally, one of the surviving strategies will be selected on the basis of best satisfying the assessment criteria listed in Section 3.0 and the requirements of CERCLA." As noted in Specific Comment 1, Section 3.0 is inadequate. For example, the quote from the TPP "IRA's are "removal" actions" [sic] cannot be considered a criteria for evaluating an IRA strategy. The final assessment should conduct an evaluation of strategies against clearly stated criteria.

RESPONSE:

Shell has included both a list of evaluation criteria and the evaluation of each strategy and system alternative against listed criteria in the Final Alternatives Assessment.

6. COMMENT:

Section 5.4, page 5-16. Relative to the statement on remediation of contaminated groundwater, it should be stated more clearly that a relatively small volume of groundwater would be removed from within the physical barrier for the purpose of creating a reverse hydraulic gradient in order to

enhance containment and mitigate the threat of release of contaminants from the Shell trenches. This water would have to be treated to be disposed of. In view of the fact that groundwater entering the site is already contaminated and only becomes more contaminated as a result of releases from the Shell trenches, overall groundwater remediation is clearly beyond the scope of this IRA.

RESPONSE:

In principle, we agree with the Army's conclusion that groundwater remediation is not appropriate for this IRA.

7. COMMENT:

Section 5.4.1.1, page 5-16. At the bottom of the second paragraph the discussion on single-bore wells versus well points in moderate to high permeability sediments is not clear. Why is a dense network of well points necessary in high permeability sediments? If radically different extraction rates are associated with these different techniques, that should be noted in the final assessment.

RESPONSE:

The discussion on groundwater extraction has been changed in the Final Alternatives Assessment. The issues pertinent to this comment are not included in the Final Alternatives Assessment because they are not critical determinants for the evaluation or selection of alternatives.

8. COMMENT:

Section 5.4.3.6, page 5-25, second paragraph, last sentence. Does this statement mean that the concentrations of contaminants in the groundwater are higher than can effectively be treated with a trickling filter process? This should be clarified in the final assessment.

RESPONSE:

This statement is not included in the Final Alternatives Assessment because it is not a critical determinant in the evaluation or selection of alternatives.

9. COMMENT:

Section 6.0, page 6-32. Same as General Comment 3; the section is titled "Evaluation of System Alternatives" and the discussion is on the same strategies previously presented. In addition, similar to Specific Comment 1, the referenced Section 3.0 does not adequately set forth evaluation criteria or guidelines.

RESPONSE:

The text has been modified so that strategies are first presented, evaluated, and an appropriate one selected; technologies that achieve the selected strategy are discussed and those appropriate selected; and finally system alternatives (which comprise combinations of appropriate technologies) are described, evaluated, and the preferred one selected. Shell has used this hierarchical approach to

streamline the number of alternatives that must be evaluated.

10. COMMENT:

Section 7.0, page 7-36. The Army agrees that containment is appropriate for this IRA but has concerns on some specific points:

- Considering containment of the contaminants at the Shell trenches to be part of the final remedy is conjecture at this time and should not be used to support the conclusion.

- No cost analysis is presented to support the statement that containment is the most cost-effective strategy.

RESPONSE:

We agree with the Army's comment that it may be premature to assume that containment is part of the Final Remedy and that this assumption should not be used to support the conclusion of containment. However, we believe that it is reasonable to assume that containment contributes to the Final Remedy by reducing the spread of contamination and have noted this in the Final Alternatives Assessment.

Cost estimates are included in the Final Alternatives Assessment.

11. COMMENT:

Section 7.1.3, pages 7-37 and 7-38. The Army supports the concept of using ongoing investigations to refine and improve the IRA assessments, as they develop and find this approach consistent with its treatment of the other hot spots.

RESPONSE:

No response required.

12. COMMENT:

Section 2.1, page A-5, top of the page. The cited well (36067) is a downgradient well. Does Shell mean Well 36163 which is within the Shell trenches area? This should be clarified in the final assessment documents.

RESPONSE:

Well 36067 is cited correctly in the text.

13. COMMENT:

Section 2.2.1, page A-6. The Army is very concerned that Shell is apparently not following USATHAMA procedures for monitoring well installations. USATHAMA requires a 5-foot sand pack above the screened interval prior to placement of the bentonite seal. In addition, a 5-foot bentonite seal is required. The Army requests an explanation as to why these procedures were not followed for this RMA investigation.

RESPONSE:

The depth to groundwater beneath ground surface in the study area varied from approximately 5 to 10 feet in August 1989. Water levels in the past 5 years have been up to 4 feet higher. Since the nature of the contaminants in the trenches indicates that separate-phase liquids may be present (both light and dense), wells were installed so that the top of screens were approximately 1 to 2 feet above recent high water levels. This construction of wells allows light non-aqueous phase liquids (LNAPLs) to flow into the wells so that they can be detected and measured. However, because the depth to groundwater is so shallow within the study area, the top of the screens are very shallow (i.e., less than 10 ft). Therefore, a 5-ft sand pack above the screen and a 5-ft bentonite seal above that cannot be installed (i.e., the bentonite seal would be above the surface of the ground). In these instances, we have modified the well construction so that LNAPLs can be measured and have used 1 to 2 foot bentonite seals. This thickness of bentonite is adequate in areas such as the Shell Trenches where the top of the screen is less than 5 feet below ground surface.

We believe that the importance of having wells that monitor LNAPLs (which have not been found in any of the wells in the Shell Trenches) justify slight variances from standard RMA well construction procedures. We hope that the Army agrees with these reasons for variance and are available to discuss them further.

14. COMMENT:

Section 2.2.2, page A-7. Similar to Comment 13 above, the Army is concerned that USATHAMA procedures were not followed. Five casing volumes plus five times 30% of the annular volume should be purged prior to sampling. The rationale for deviating from this protocol should be explained.

RESPONSE:

Variances in well development are used for wells that are bailed dry during purging prior to sampling. The variances are similar to those standardly used for sampling under the Comprehensive Monitoring Program for wells that are bailed dry prior to sampling. During sampling, wells are bailed dry, allowed to stabilize, and sampled. These variances are only used when standard procedures are not feasible.

SHELL RESPONSES TO EPA COMMENTS ON THE DRAFT FINAL ALTERNATIVES ASSESSMENT OTHER CONTAMINATION SOURCES IRA, SHELL SECTION 36 TRENCHES

RESPONSES TO GENERAL COMMENTS CONTAINED IN THE TRANSMITTAL LETTER

Paragraphs 1,2, and 3

The Final Alternatives Assessment has been rewritten so that the overall approach taken by Shell will be clearer to the EPA. Shell has taken an approach that is somewhat different from the Army's approach because we have followed guidelines presented in the Federal Facility Agreement rather than NCP procedures for evaluation and selection of final remedies. Our approach is to minimize alternatives by evaluating general interim response actions (i.e., strategies), then evaluating only those system alternatives within the selected strategy. By conducting the evaluation in this way, the number of alternatives is reduced and much of the evaluation can be conducted based on criteria other than cost (i.e., protection of human health and the environment and timeliness).

Paragraph 4

The lack of pesticide data (although unfortunate and inconvenient), is not a critical determinant for the selection of a preferred alternative for this site. If the evaluation of alternative strategies and systems had been dependent on the feasibility of treating organochlorine pesticides or if pesticides were the only contaminants emanating from the site, additional groundwater data would have been collected and organochlorine pesticides quantified. However, these conditions did not prove to be true for this site and an evaluation of

alternatives could be conducted based on other hydrogeological and chemical data.

The initial field investigation was conducted to determine whether the trenches are a source of groundwater contamination. Data gathered showed that the trenches contribute contamination to groundwater beneath the site. Quantifying the contribution of contaminants from the trenches versus upgradient sources was not necessary for the purposes of evaluating appropriate alternatives for this site.

RESPONSES TO SPECIFIC COMMENTS

1. COMMENT:

Page V, we support the intent to investigate Upper Denver Formation contamination as one of the elements of this IRA, if contamination levels at the alluvial/Denver interface justify this.

RESPONSE:

As indicated in the Final Alternatives Assessment issued with these responses, an eluvial clay layer (which has a low estimated vertical hydraulic conductivity) underlies the trenches. This clay layer inhibits the vertical migration of contaminants from the trenches and, for the purposes of this IRA, is believed to provide an effective barrier between contaminants in the trenches and the Denver Formation. Additionally, because of the presence of DNAPLs in the trenches, any field investigation of the upper Denver Formation may cause cross contamination into the Denver Formation and may be best postponed until a Final Rèsponse Action has been conducted on the trenches and any underlying contaminated alluvial sediments. For these reasons, further investigation of the upper Denver Formation is not currently planned for the Shell Trenches.

2. COMMENT:

Pages 3-4 and 7-36, In light of our understanding, the FFA title for this IRA ("Remediation of Other Contamination Sources"), etc., we are concerned with the statement that "the objective is not remediation." Were that true, much of

the analysis of ground water treatment options could have been dismissed from the beginning. Please revise the text.

RESPONSE:

We disagree that the objective of the "hotspot" IRAs is remediation. As specified in the Final Technical Program Plan FY88-FY92, the objective of the IRAs is to mitigate the threat of release of selected "hotspot" sources. This objective does not require remediation. However, remedial action is not precluded if it best meets the objective of mitigating the threat of release and the IRA criteria.

3. COMMENT:

Page 4-5, Section 4.1, Item 1, please provide further details on the "analytical parameters appropriate for the site." Further, please provide more detail on the determination of the trench boundaries and state whether boring data assisted in this determination.

RESPONSE:

The objective of the initial field investigation was to determine whether the site is a source of contamination. Analytical parameters were selected using standard techniques of reviewing available records of compounds that may have been disposed in the trenches and selecting a wide suite of RMA target analytes that would indicate whether the trenches are a source of groundwater contamination.

The approximate trench boundaries were determined simply by reviewing aerial photographs (i.e., looking at where the

trenches were at different points in time), reviewing all documents available that may contain maps of the trenches, and plotting a conservative boundary according to the information available.

4. COMMENT:

Page 4-6, last paragraph, please expand the text to state whether the insulation is known to contain asbestos.

RESPONSE:

We are not aware of any information on the composition of the insulation.

5. COMMENT:

Table 1 (continued), please explain the meaning of the asterisk.

RESPONSE:

The meaning of the asterisk has been included on the table as a footnote.

6. COMMENT:

Page 4-8, please provide documentation detailing the failure of the data on organochlorine pesticides and organosulfur compounds to meet "acceptable control criteria." Please provide at least the general ranges of the concentrations of these compounds for discussion. The concern for the pesticides is very high, given the uses of the trenches.

Additional sampling and analyses for these contaminants is necessary. It is stated that this exclusion of data does "not alter the evaluation of alternatives and conclusions set forth in this document." Please provide a thorough explanation of this assertion.

RESPONSE:

The failure of the organochlorine pesticides to meet acceptable control criteria was a result of laboratory QA/QC data (i.e., control spike recoveries) falling outside acceptable ranges established for PM-RMA data. The source of the low spike recoveries was not readily identified, but resulted in recoveries that were either substantively lower than normal, in some cases zero.

The objective of the initial field program was solely to determine whether the trenches are a source of contamination. Since numerous other compounds were determined to be migrating from the trenches in relatively high concentrations, the trenches could be identified as a source of contamination without organochlorine data.

For the evaluation of alternatives, specific data on organochlorine pesticides are only relevant for alternatives that extract and treat groundwater. Since all alternatives contain all contaminants, it is not critical that the concentrations of organochlorine pesticides be identified. Therefore, the lack of data on organochlorine pesticides does not preclude the conclusion that the trenches are a source of contamination, nor does it alter the assessment of alternatives which is based on numerous volatile and semi-volatile organic compounds.

7. COMMENT:

Table 2, the Assessment addresses only groundwater contamination. Were soils contamination considered and evaluated in the assessment? Do you intend that they be addressed in some future IRA assessment of the site? If the assessment evaluated the soils, please present the results.

RESPONSE:

Soil data were collected as a part of the RI and are reported in Contamination Assessment Report listed in Section 6.0 of the text. The soils data were not included in this report because they were not necessary for the evaluation of containment alternatives.

8. COMMENT:

Page 4-11, please state that the future field work will quantify the contributions from the trenches and from upgradient sources.

RESPONSE:

Shell does not plan to quantify the contributions of contaminants from the trenches versus upgradient sources because it is not necessary for the evaluation or implementation of this IRA.

9. COMMENT:

Page 5-21, Section 5.4.3, Water Treatment. The treatment of inorganics (arsenic) is not identified or discussed in this section. Since the Shell disposal trenches are identified as a probable source of arsenic contamination in Table 2, the treatment of arsenic in the ground water should be included.

RESPONSE:

For alternatives that include groundwater extraction, treatment is proposed to be conducted in the proposed CERCLA wastewater facility. This facility is capable of treating arsenic.

10. COMMENT:

Page 5-26, reverse osmosis and ultrafiltration were dismissed from further consideration because extensive pilot testing would be required; please state whether this is not also the case for biological treatment, which has been retained for further consideration.

RESPONSE:

We agree that extensive pilot testing would be necessary for biological treatment.

11. COMMENT:

Page 6-35, Section 6.2, Ground Water Interception and Treatment. The text states, ". . . the facilities constructed for a ground water containment and treatment system may not be consistent with the Final Remedy . . . (and) would require additional O & M and administrative costs." These statements appear to be the sole bases for not including ground water treatment in the IRA at this time. Without strong justification that a ground water treatment system as part of this IRA would compromise or affect the final remedy for the site, given the documentation that we now have available to review, EPA would find it difficult to make a decision which would not include such a system.

RESPONSE:

The text has been reorganized and the evaluation of alternatives revised. A cost estimate is provided for a groundwater intercept alternative and functional advantages and disadvantages are used to evaluate its benefits in comparison with other alternatives.

12. COMMENT:

Page 7-37, Section 7.1.1, what are the effects of a barrier alone on the hydrology?

RESPONSE:

Since the trenches are probably a main source of recharge from precipitation, a physical barrier encircling the

trenches would prevent flow to the surrounding area and consequently result in decreasing water levels outside the barrier. Without a soil and vegetative cover, water levels inside the barrier would increase.

13. COMMENT:

Page 7-38, is the current reliance on the cone penetrometer testing sufficient to characterize site conditions to allow alternative selection?

RESPONSE:

The cone penetrometer technique has been used successfully at numerous hazardous waste sites. In the Shell Trenches, six continuous-core boreholes were installed adjacent to CPT holes to evaluate the correlation between the CPT logs and existing sediments. In all six comparisons, the CPT logs correlated very well with core samples. We believe that the CPT provided a cost-effective and technically sound technique to collect detailed stratigraphic information. The information gained from the CPT has greatly enhanced our understanding of the site and, therefore, our ability to assess alternatives.

14. COMMENT:

Page 8-40, please present a schedule for the completion of the field work to fill the existing data gaps. Reissuance of the Assessment after completion of this field work, development of a supplement, or some other option to present this data and revise the recommendations appropriately, may be necessary.

RESPONSE:

The field work has been conducted and the results are published in "Results of Field Investigations Conducted August and September 1989, Shell Section 36 Trenches, Rocky Mountain Arsenal" sent to the EPA in December 1989. The Final Alternatives Assessment has been revised to include these new data.

15. COMMENT:

Page 8-40, please expand the statement that "groundwater contamination has changed recently."

RESPONSE:

This statement was incorrect. Groundwater data collected under the RI and IRA do not indicate significant changes in concentrations of contaminants near the trenches. The text has been changed.

16. COMMENT:

Table 1, is this a thorough list of all wastes placed in the trenches?

RESPONSE:

No accurate or complete disposal records were maintained during the operation of the trenches. Table 1 is a list of compounds probably disposed in the trenches; it was compiled from historical process and/or financial records and cannot be assumed to be comprehensive or entirely accurate.

SHELL RESPONSES TO STATE COMMENTS ON THE
DRAFT FINAL ALTERNATIVES ASSESSMENT
OTHER CONTAMINATION SOURCES IRA, SHELL SECTION 36 TRENCHES, RMA

RESPONSES TO GENERAL COMMENTS:

1. COMMENT:

Interim response actions (IRA) were designed to remove the source of that contamination via excavation or in-situ immobilization. This objective has been misconstrued by Shell to the extent that Shell has stated that source removal "is not well suited for an interim response action," (page 5-30), and is "not consistent with IRA Criteria and Guidelines" (page 6-32).

The State believes that the removal strategy rejected by Shell must be retained and evaluated as the most viable IRA remedial alternative. As Shell correctly states, on page 5-30, "Removal of the trench contents would effectively mitigate the threat of releases of contaminants from the site," which is the objective of the "hot spot" IRAS. Trench excavation, segregation of materials into compatible wastes, and temporary on-site storage pending selection of a final Feasibility Study (FS) alternative would satisfy the objective of the Remedial Investigation (RI) to characterize the waste and estimate the volumes, and the IRA to expeditiously remove sources of severe contamination. This IRA alternative would also lead directly to the subsequent selection of a treatment technology or technologies which could then be implemented during the FS.

As Shell correctly states, "Removal of the trench contents would effectively mitigate the threat of releases of contaminants from the site," which is the objective of the "hot spot" IRAs (page 5-30).

RESPONSE:

As specified in paragraphs 22.6 and 22.7 the FFA, the criteria used to assess interim response action alternatives for the "hotspot" IRAs include protection of human health and the environment, reasonableness of cost, cost-effectiveness, attainment of ARARs to the maximum extent practicable, timeliness, and consistency with and contribution to the Final Response Actions to the maximum extent practicable. As explained in the Draft Final and Final Alternatives Assessments for the Shell Trenches, excavation is eliminated as an appropriate strategy not because it does not meet the objective of the IRA, but because other alternatives better meet the guidelines of reasonableness of cost, cost-effectiveness, or timeliness.

RESPONSES TO SPECIFIC COMMENTS:

1. COMMENT:

Page 4-6. The text states that the list in Table 1 contains some inaccuracies. What are these "inaccuracies"?

RESPONSE:

The text has been modified to be more specific.

2. COMMENT:

Table 1: The following analytes are among those listed in Table 1 as compounds disposed of in Shell Section 36 Trenches:

A. Bicychloheptadiene (Volatile Hydrocarbon Compounds, "VHC").

B. Chlorobenzene (Volatile Halogenated Organics, "VHO").

C. Chlorophenylmethyl sulfone, Parathion, Vapona (Semivolatile Organics, "SVOs").

If the April 1989 groundwater samples were not analyzed for these compounds, a second sampling round for these analytes should be completed. Resampling would also allow for reanalysis of organochlorine pesticides (OCPs) and organosulfur compounds (OSCs) which did not meet control criteria in the first sampling episode.

RESPONSE:

The April 1989 groundwater sampling program was designed to determine whether the Shell Trenches are a source of groundwater contamination. The compounds that were analyzed during that program included all RMA target analytes for which the laboratory was USATHAMA-certified. These data were sufficient to determine that the trenches are a source of contamination of numerous volatile and semi-volatile compounds. Additional groundwater data would be collected only if necessary either for the evaluation of alternatives

or the design of an alternative for which additional data are required. In the case of the Shell Trenches, neither of these situations is applicable. Therefore, Shell is not planning additional groundwater sampling at this time.

3. COMMENT:

Table 1: The text should specify the "heavy hydrocarbon" compounds that are referenced in Table 1. If these compounds are dense nonaqueous-phase liquids (DNAPL), an investigation is necessary to characterize their extent and distribution beneath and downgradient of the CSA-1a trenches.

RESPONSE:

We have no further information on the composition of the "heavy hydrocarbon."

4. COMMENT:

Page 4-10. Shell states that "contaminants flow preferentially to the north of the trenches rather than to the northeast or northwest." They base this on geochemical data from Wells 36063 (northeast of CSA-1a) and 36508 (northwest of CSA-1a), respectively. However, an examination of the potentiometric surface presented in the Central Study Area Report (CSAR) Plate CSA 1.5-2 indicates that Well 36063 (the northeastern well) is too far east to intercept groundwaters influenced by CSA-1a. Therefore, data from this well cannot be used to draw conclusions about a northeast component of flow downgradient from the Shell disposal site (e.g., conclusion number 2 presented on

page V). Therefore, the first summary paragraph on 4-11 must be modified or removed. Determination of flow directions is essential in evaluating the area of influence impacted by CSA-1a contaminants. The placement of an alluvial well bisecting the line between Cluster Wells 36509/36510 and Well 36063 would provide data necessary for the evaluation of a northeastern component of flow.

RESPONSE:

A well has been installed in the location suggested by the State. The water chemistry supports the conclusion made on page 4-11 that contamination appears to flow primarily to the north and northwest. Additionally, the potentiometric surface presented in the Central Study Area Report (referenced in the State's comments) shows that flowlines trend to the northwest into Basin A; these flowlines also support the conclusion stated in the Draft Final Alternatives Assessment that data "suggest that predominant contaminant flowpaths trend to the north from the trenches."

5. COMMENT:

Page 4-11. Shell states, "As illustrated by one alluvial cluster well (36509, 36510) concentrations of most analytes appear to decrease with depth in the alluvial aquifer. This apparent decrease may indicate that vertical leakage of waste materials from the trenches has been minimal and has been confined to sediments within and immediately beneath the trenches." The State agrees that the sampling data from well 36509, the shallower well, indicates higher concentrations of most analytes in that well than in the deeper well numbered 36510. However, several of the analyte

concentrations (As and DIMP) are within the same order of magnitude for the two wells, indicating perhaps an insignificant decrease in concentration. Additionally, Well 36509 is screened over a 15-foot interval, while Well 36510 is screened over a five foot section at the base of the aquifer. Without knowing the exact sampling interval within the upper level, it is impossible to determine the vertical distribution of contaminants across the water column.

Because of the presence of contaminants within both wells, the discrepancy between screened intervals, and the fact that data are presented for only one cluster group, Shell's characterization of the vertical extent of contamination beneath the trenches is incomplete and the above statement is unsubstantiated.

RESPONSE:

The referenced paragraph states "As illustrated by one alluvial cluster well, concentrations of most analytes appear to decrease with depth in the alluvial aquifer. This apparent decrease may indicate that vertical leakage of waste materials from the trenches has been minimal and has been confined to sediments within and immediately beneath the trenches" [emphasis added]. This conclusion is sound in light of available data and all necessary qualifiers are included in the paragraph.

6. COMMENT:

Page 5-15. Shell lists "containment combined with groundwater treatment" as an alternative on page 5-15, but fails to list it in either the Technology Alternative

(Section 5.0, page 5-12) or Evaluation of System Alternatives (Section 6.0, page 6-32). Please explain this inconsistency.

RESPONSE:

The text has been modified to eliminate this inconsistency.

7. COMMENT:

Pages 5-30 and 5-31. The arguments provided by Shell against consideration of a removal strategy as a possible interim response measure are incorrect and insupportable. These comments include:

Comment No. 7A:

Page 5-31. Shell states, "A meaningful development . . . of technology alternatives for this strategy is . . . precluded by the paucity of information presently available . . . on the characteristics of the wastes in the trenches."

This statement clearly indicates that Site CSA-1a has been poorly and incompletely characterized in the RI, and that additional data collection is necessary prior to implementing the FS. Selection of the excavation strategy as an IRA would provide essential data on waste characterization and volumes. Additionally, analysis of historical and field data has resulted in a better understanding of trench locations, structure, and contents (page 4-6, and Table 1). Therefore, a "meaningful development" of the removal strategy is both viable and beneficial to the FS program.

Response No. 7A:

Shell notes that an argument described by the State as "incorrect and insupportable" is then cited as authority to support the State's argument of an allegedly incomplete RI. Moreover, Shell disagrees that the arguments against the excavation strategy are incorrect and insupportable. In contrast, Shell believes that the conclusions reached are logical, technically sound, appropriate, and supported by available data and the guidelines specified in the Federal Facility Agreement.

As stated in the Final Alternatives Assessment, the criteria used to assess interim response action alternatives for the "hotspot" IRAs include protection of human health and the environment, reasonableness of cost, cost-effectiveness, attainment of ARARs to the maximum extent practicable, timeliness, and consistency with and contribution to the Final Response Actions to the maximum extent practicable. As described in the Draft Final and Final Alternatives Assessments for the Shell Trenches, excavation is eliminated as an appropriate strategy not because it does not meet the objective of the IRA, but because it does not meet the guidelines of reasonableness of cost, cost-effectiveness, or timeliness. Containment not only meets the objectives of the IRA, but also meets all of the criteria used to assess each alternative strategy. Therefore, containment is preferred over the alternative of excavation.

Shell believes that the State's judgment that the Shell Trenches were incompletely characterized during the RI is not relevant to this IRA or the document under review. We

reiterate that the excavation strategy is eliminated as a viable strategy because in comparison with containment it is not reasonable in cost, cost-effective, or timely.

Comment No. 7B:

Page 5-30. Shell states, "It is possible that adequate waste characterization for this strategy could only be achieved by methodical excavation of all the waste in the trenches."

The State agrees. Thus, excavation is necessary to develop the requisite information for an FS evaluation.

Response 7B:

See Response 7A above.

Comment No. 7C:

Page 5-30. Shell states, "The period of time required to implement this strategy [removal] would be very long . . ."

This statement is unsubstantiated. Time estimates for implementation of both this strategy and the containment option should be included in the Assessment Document.

Response 7C:

Time estimates for both the containment and excavation strategies are included in the Final Alternatives Assessment.

Comment No. 7D:

Pages 5-30 and 5-31. Shell states, "This strategy would also involve a large expenditure entailing the risk of being inconsistent with the Final Remedy."

Since the objectives of any Final Remedy must be removal or immobilization of contaminant sources, it is incomprehensible to conclude that source removal and subsequent waste characterization would be inconsistent with such a Final Remedy selected in accordance with CERCLA and the National Contingency Plan (NCP). Excavation of Shell trenches satisfies IRA criteria and guidelines. Though excavation is not a final remediation (the FS will need to address cleanup of contaminated groundwater, soils, and waste materials removed from the trenches), the strategy can be implemented on a timely basis and will clearly mitigate the threat of contaminant releases.

Response 7D:

As stated in the text, excavation of the relatively large volume of complex and heterogeneous materials in the trenches would require careful, methodical excavation methods. Excavation techniques using large equipment and the short period of time for implementation of an interim response action are not appropriate to this site because of the complexity and uncertainty of the disposition of the drums and materials in the site. Excavation and waste characterization are estimated to require 4 to 5 years and cost up to $100 million or more. This means that excavation may require longer than the total life of an IRA and cannot be conducted in a timely or cost-effective fashion.

We believe that it is inappropriate to make assumptions about the Final Remedy. For example, containment or in-situ remediation technologies may be available and acceptable at time that the ROD is issued. If so, source removal and subsequent waste characterization would not be necessary and would be inconsistent with the Final Remedy.

Comment No. 7E:

Page 5-31. Shell states, "the IRA objective and guidelines for this site are satisfactorily met in a more cost-effective . . . manner by a contaminant [sic] strategy."

This statement is unsubstantiated. No cost estimates have been provided for any of the response actions proposed for this IRA. In addition, excavation and treatment of waste materials during implementation of the final remedy would entail destruction of any cap constructed as an IRA. Placement of such a cap, therefore, is likely to be inconsistent with the final remedy, and not cost effective.

Response 7E:

Cost estimates are provided in the Final Alternatives Assessment. Since the Final Remedy is not known, it is not possible to determine whether a "cap" will be inconsistent with the Final Remedy. A soil and vegetative cover is a cost-effective technology that is protective of human health and the environment and can be implemented in a timely manner.

Comment No. 7F:

Page 5-31. Shell states, "implementation of this strategy as part of the Final Remedy . . . would be advantageous because . . . risks to the environment, workers, and public, would be appreciably reduced by the presumed availability of the management and facilities infrastructure associated with overall RMA final remedial actions."

Because engineering procedures for minimizing dust and odor emissions are commonly employed on hazardous waste sites, excavation of trench materials could be conducted in a manner which would result in minimal risk to the environment and public health. Again, trench locations and structure are well documented (approximately 31 trenches in 18 east-west trending rows; trenches range from 40 to 660 feet in length, 10 to 20 feet in width, and 5 to 10 feet in depth, and are separated by 3 to 23 feet of undisturbed soil). This documentation can be used in the design of the excavation program. The level of worker protection required onsite will be contingent upon the types of waste materials that could be encountered in the trenches, in the same ways all worker protection levels are determined. Facilities necessary for completion of the IRA would include a temporary pad on which to store and segregate contaminated wastes.

Response 7F:

The State may have misunderstood the statement referenced in this comment. We did not intend to imply that excavation could not be conducted in a manner that minimizes dust and odor emissions; rather, the statement refers to the

efficiency and consequent cost-effectiveness and reliability of conducting excavation, waste separation, and treatment of wastes when the infrastructure of remedial construction activities are in place and standards for such have been established. For example, wastes removed from the trenches during an IRA would need to be temporarily stored (for a minimum of 5 to 10 years). However, wastes excavated during a Final Response Actions may ideally be characterized and treated or disposed soon after excavation. The risk of exposure to workers and the community decreases and the efficiency of the process increases.

As a minor point, we disagree that the "trench locations and structure are well documented". As referenced in the Alternatives Assessment, the current descriptions and knowledge of the location and structure of the trenches was obtained from a geophysical study conducted by HLA and Shell memos written in the 1980s. No documentation of the exact location of the trenches, nor the exact depths or widths was recorded.

8. <u>COMMENT</u>:

Page 6-34. The Basin A Neck treatment facility, despite repeated State protestations, has not been designed to treat arsenic and other inorganic constituents. Therefore, use of the facility is not an acceptable alternative for the treatment of CSA-1a extracted groundwater since this groundwater contains extremely high concentrations of such inorganics.

RESPONSE:

The Basin A Neck treatment facility is not considered for treatment of extracted groundwater in the Final Alternatives Assessment.

9. **The State did not provide a comment labelled No. 9.**

10. COMMENT:

Shell has selected a preferred remedial alternative without presenting capital and O&M costs for preferred or rejected alternatives, while at the same time, using a cost comparison argument between containment and excavation alternatives to reject the latter strategy. The assessment should contain cost estimates for the following alternatives proposed by Shell in addition to the excavation alternative.

A. Monitoring and Maintenance

B. Containment:

1. slurry wall
2. sheet piling
3. grouting
4. surface capping
5. hydraulic barrier

C. Containment and Treatment:

1. groundwater extraction - wells
2. groundwater extraction - drains
3. groundwater recharge - wells

4. groundwater recharge - drains
5. groundwater recharge - leach fields
6. water treatment - air stripping
7. water treatment - biological treatment
8. water treatment - carbon adsorption
9. water treatment - oxidation

D. Excavation (Removal)

With the exception of D, the above alternatives have been identified by Shell as potential IRAs for Site CSA-1a. Again the removal strategy should be included for IRA evaluation.

RESPONSE:

The Final Alternatives Assessment contains cost estimates for system alternatives. Cost estimates are not presented for different processes; they are presented using representative processes for each technology. The cost estimates are presented for comparison and evaluation of cost-effectiveness for each alternative. These comparisons can be effectively conducted using representative processes. Individual processes will be evaluated during engineering design.

11. COMMENT:

Page 7-36. Shell states that the selection of a containment system alternative satisfies IRA objectives by "mitigation of the threat of release of contaminants from the source." Emplacement of a physical hydraulic barrier will not mitigate release of contaminants; the contaminant source

will still contribute analytes to groundwater and soils. Shell should correct this inaccuracy.

RESPONSE:

There is no inaccuracy to correct. Containment will prevent the migration of dissolved plumes and DNAPL away from the trenches and, therefore, clearly mitigates the threat of release of contaminants to all areas surrounding the physical barrier.

12. COMMENT:

Page 7-37. The five analytes listed in Specific Comment number 2 should be included in any groundwater monitoring program designed for CSA-1a.

RESPONSE:

The monitoring network, frequency of sampling, and analytes used for the IRA monitoring program will be chosen as a part of the engineering design for this IRA. Careful consideration of monitoring objectives and techniques to achieve those objectives will be made to determine these issues and may not necessarily require all the analytes listed by the State.

13. COMMENT:

Page 7-38. Section 7.1.4 is entitled "Investigation of Contamination of the Upper Denver Formation." Please explain the inclusion of this section in the draft assessment document. If evaluation of geochemical and

hydrogeological data indicate the potential for migration of contaminants into Upper confined Denver units, this data should be evaluated by the Vertical Extent of Contamination Committee.

RESPONSE:

Section 7.1.4 was based upon knowledge at the time it was written. Since the issuance of the Draft Final Alternatives Assessment, an eluvial clay layer underlying the trenches and overlying the Denver Formation has been identified. This layer provides a barrier to vertical contaminant migration from the trenches. Therefore, the Final Alternatives Assessment does not include a potential investigation of the upper Denver Formation as a part of the preferred alternative.

SHELL RESPONSES TO U.S. DOI COMMENTS ON THE DRAFT FINAL ALTERNATIVES ASSESSMENT OTHER CONTAMINATION SOURCES IRA, SHELL SECTION 36 TRENCHES, RMA

1. COMMENT:

Page A-16 states a condition of no significant risk to wildlife stemming from this IRA because of poor habitat quality. If the project area in question could hold runoff water following significant precipitation events, then water birds might be attracted to this site. Basin F (now partially remediated) offered no habitat for birds (or other animals) in the traditional sense, but it was a source of significant avian mortality at Rocky Mountain Arsenal (Arsenal). Standing water, if it could occur at this site and if it posed enough concentration of toxic material, could pose a hazard to birds attracted to the site. Birds or other animals could be lured to the site for drinking (or other) purposes if it was perceived as a source of water (vis a vis Basin F). Avoidance of this described potential problem might or might not require some action as part of the IRA activities planned for this site. We point this out to alert you and the IRA participants so that a problem of this type might be avoided.

RESPONSE:

The preferred alternative presented in the Final Alternatives Assessment includes regrading and revegetation of the surface of the trenches (as a part of constructing a soil and vegetative cover to eliminate recharge). This regrading will eliminate surface depressions that could collect runoff and attract avian biota.

As a note on the DOI's comment, we believe the suggestion that this site may be similar to Basin F is inappropriate and unfounded. Basin F was a 93 acre disposal basin used for liquid wastes; it contained liquid all year round for nearly 33 years. The Shell Section 36 Trenches are land disposal trenches covered by 5 to 10 feet of soil. Ponding due to runoff has been observed only in small (<1 acre) areas after prolonged storm events. The ponds have been observed to exist for less than approximately 2 weeks. The Contamination Assessment Report and Phase II Addendum to that report show that soil contamination occurs primarily between 5 to 10 feet below ground surface, not at ground surface. For these reasons, the minor ponding that occurs is not believed to present a significant risk of contamination to wildlife and the comparison between Basin F and the Shell Trenches should not be made.